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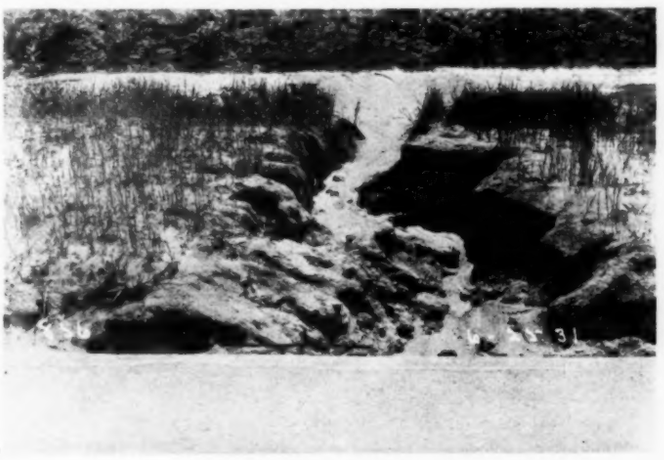
Lip Type Concrete Pavements



Erosion at Foot of a Grade

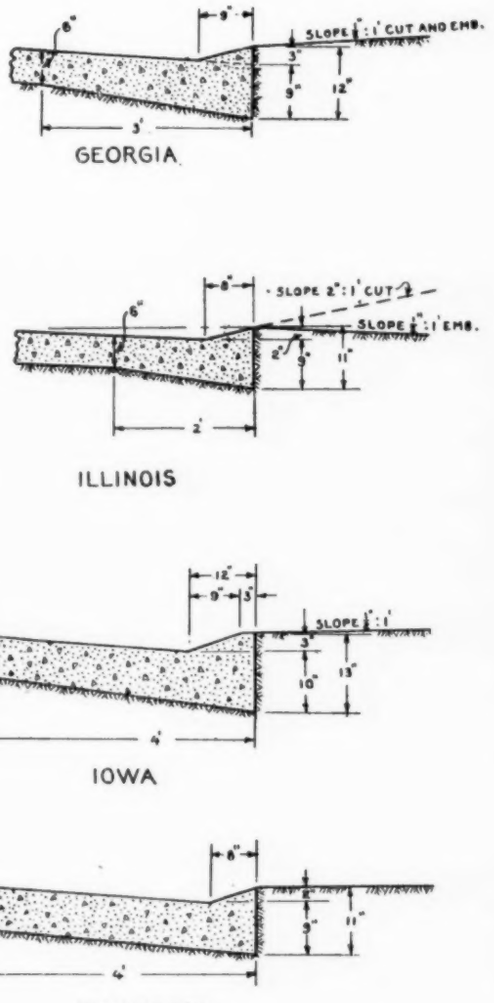
THE lip type concrete pavement as used in Missouri and several other middle western states is reported to be proving very satisfactory, both on account of the saving in expense of shoulder maintenance and the added safety given to the roads.

We are indebted to T. H. Cutler, Chief Engineer, Missouri State Highway Department, for the accompanying photographs of Missouri concrete roads with and without the lip curb. The illustration at the upper right of a concrete road without the lip curb shows the effect of erosion where the water concentrated at the foot of a grade. The picture at the lower left, also of a concrete road without the curb, was taken shortly after a shower, which while not heavy enough to moisten the ground, nevertheless placed enough water on half the pavement to wet the edge of the shoulder for a distance of 5 or 6 in. along the edge of the concrete.

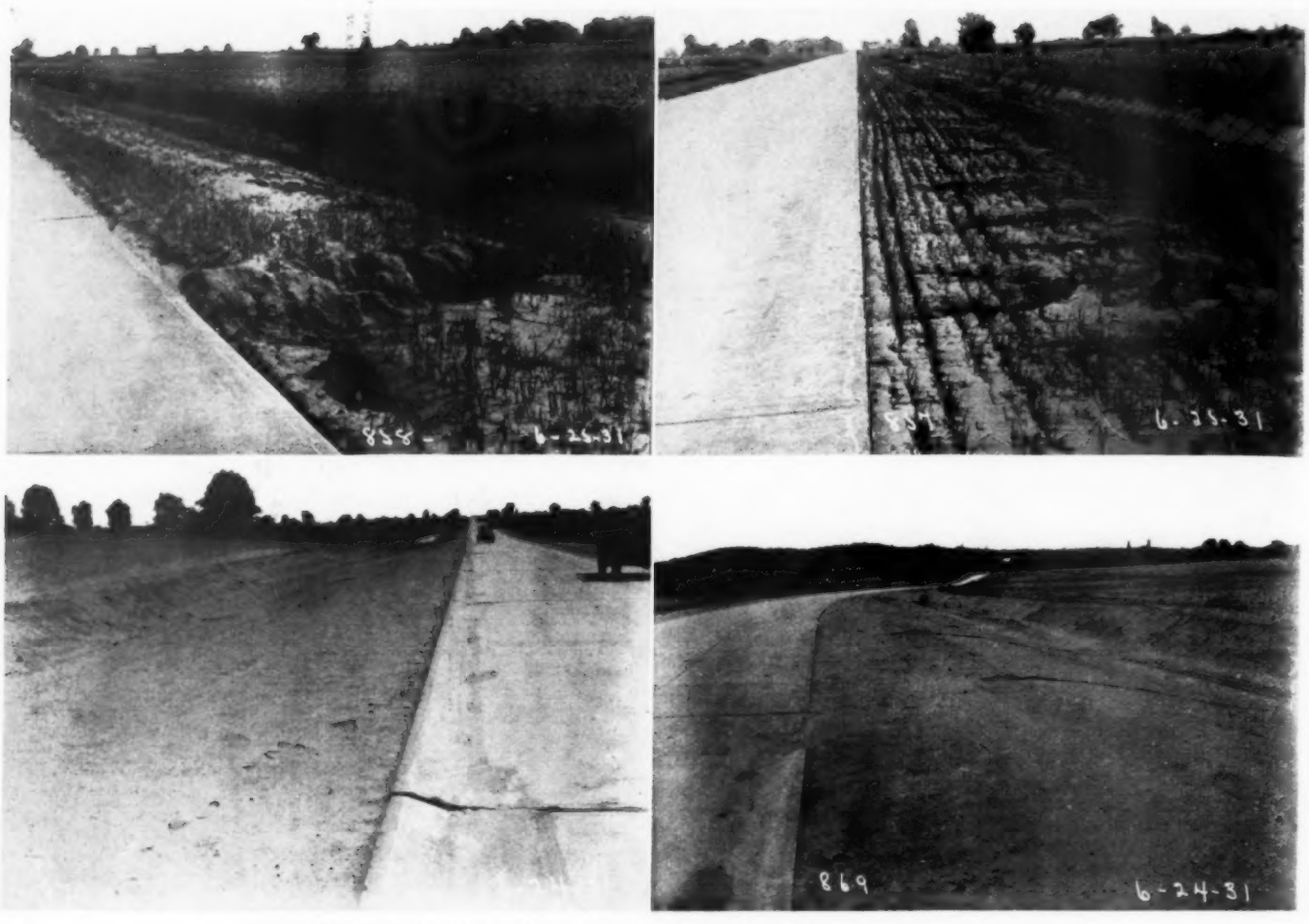
When Edge of Shoulder Is Wet

Mr. Cutler states that this picture serves to illustrate the condition usually found along the earth shoulder; that the dirt adjacent to the edge of this pavement is necessarily always much softer than the remainder of the shoulder, due to the fact that the water flowing off the pavement is concentrated along this area. Thus the shoulder may be fairly firm 1 ft. or more distance from the edge of the pavement, but very soft immediately adjacent to the pavement. This condition, of course, is hazardous, for traffic occasionally drives off the edge. It also allows the car wheel to sink in, creating a rut which concentrates water.

Figure 1 shows what happened to a sandy or easily



Designs of Lip Curbs for Concrete Pavements



Figs. 1, 2, 3 and 4.—Views of Shoulders Along Concrete Pavements

eroded shoulder when the pavement was not constructed of the lip type. Figure 2 (upper right) shows the effect of erosion. Figure 3 (lower left) is a pavement with lip curb, constructed where soil conditions very closely approximated those shown in Figs. 1 and 2 and in the picture in the upper right of the preceding page. This pavement and shoulder has undergone the same weather conditions as prevailed in the vicinity of the roads shown in Figs. 1 and 2. It will be noted that the water has been confined to the pavement and not allowed to wash the shoulder, with the result that the shoulder is in almost perfect condition. Figure 4 shows the curb ending at a point where the grade is practically flat. Under the Missouri state highway practice the lip type is not constructed except where grades are 1 per cent or more.

▼

Needed Road Work Can Keep Millions Busy

Public work, such as road building, is one of the best ways for the country to furnish employment is shown in the actual employment figures in 1931, according to W. C. Markham, Executive Secretary of the American Association of State Highway Officials.

"An average of approximately 290,000 men had road jobs on Federal Aid and state projects during 1931," Mr. Markham asserted. "It is conceded by those who have studied the subject that for every man working directly on the roads there is employment given two men who are preparing or transporting materials. On that basis the Federal Aid and state work alone was responsible for the employment of an average of 870,000 men throughout 1931. Local road work and street building brings the total number of men employed, directly and indirectly, in the improvement of automobile facilities to well over two million workers.

"To furnish work it is not necessary to avoid the use of machinery," Mr. Markham went on. "While it is true that the highest proportion of manual labor is found in hand-labor projects, such as working in virgin soil or spreading sand or gravel over an earth bed, it is also true that about nine-tenths of the road money spent for high type pavements also goes to labor. This is so because no intrinsically valuable materials go into roads; the hand of labor plays the major part in preparing these materials, in building equipment and in transporting these supplies to the project.

"The Federal government, the state and the local community can feel that when it makes a dollar available to road construction that it will be a dollar well spent, a dollar invested mostly in labor. Of great import, also, is the fact that this country needs many thousands more miles of good highways, highways that will cut down car operating costs to the individual and road upkeep costs to government. The public is now paying a tremendous tribute to these two items which can only be reduced by building adequate road surfaces.

"The prevailing low construction prices, the economic need for improved highways and the all important call for more jobs make this a time when every community should devote every cent possible to roads," concluded Mr. Markham.

The GASOLINE TAX *As It Relates to the* HIGHWAY PROGRAM

By CHAS. M. UPHAM
Engineer-Director, American Road Builders' Association

The gasoline tax is a special tax for a special purpose—a road toll paid by motorists for the building and upkeep of the roads they use.

A LITTLE more than a decade ago the motorists of the country came forward and demanded the speeding up of the construction of more miles of roads. Knowing that funds were not available for such purposes, these same motorists offered to make funds available by voting taxes on motor vehicles provided these revenues were used solely for road building and maintenance. Thus the gas tax came into being—being a special tax for a special purpose. It is a revenue suggested, legislated, and paid by these motorists.

From a small beginning, experimental in a few states, but now thoroughly established and accepted, this tax has become the backbone financially of the highway industry. Since 1919 this tax, as evidence of its fairness, has been adopted by every state in the Union. The revenue in 1919 amounted to $1,022,514.00. In 1930 it had increased to $493,865,117.00. This amount, plus the revenue from automobile registration gives a total income for 1930 of $849,569,977.00. Such an amount represents a total equal to 90 per cent of the annual state and federal highway construction expenditures.

It is a tax based on sound principles, providing benefits for those paying the tax in proportion to the amount paid and from the source which has the ability to pay.

Recently, and parallel with the increase of the gas tax revenues, there have appeared those advocating the diversion of the gas tax for purposes other than the construction and maintenance of highways. Tendencies in this direction are evident in almost every state legislature. Among the purposes foreign to highways to which this fund has been diverted, will be found sea walls, docks, aviation fields, public buildings, and oyster propagation. Such diversion will breed dissatisfaction and can only result in the refusal of the automotive public to continue to supply a revenue which is most vital in the economic development of our highway transportation system.

To divert any portion of this fund for any purpose other than the construction and maintenance of highways is to take from those who sponsored and are paying the tax that which is justly theirs.

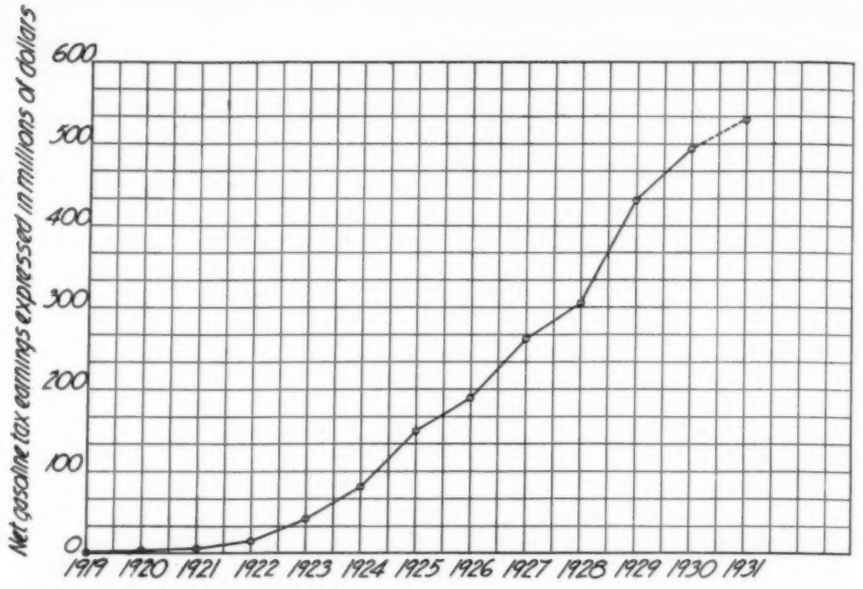
Of the 3,200,000 miles of roads in the United States, only 700,000 miles have been improved in any manner, and only 128,000 are paved. There are 2,500,000 miles which are still mud roads. Many of the state highway systems, which at the present time are carrying the bulk of the traffic, are far from complete. At the present rate of improvement, reconstruction will be upon us before such systems have been completed. Within cities congestion due to narrow and inadequate pavements is causing great economic loss. No more striking example of the tremendous economic loss can be obtained than by cognizance of the fact that there has been in congested areas a large return to the horse drawn commercial vehicle, the time advantage of the motor truck having been eliminated by traffic congestion.

In the past five years automobile registration has increased 40 per cent while the amount of road building has only increased 13 per cent. Personal transportation demands a normal increase in our present street and highway systems. This is evidenced by a death toll of 32,000 people in 1930.

The task of building the highways of the United States is hardly begun. There are 3,200,000 miles of road, of which only 700,000 miles have been improved and only 128,000, or 4 per cent, have been paved.

Highway expenditures are today meager when compared with the volume of work to be done in providing adequate arteries of transportation for continued economic progress. When the revenue from gasoline taxes is invested in the construction and maintenance of roads, there is an immediate saving in transportation costs. Motor vehicle owners are becoming increasingly alert to the reduction in operating costs, due to surfaced roads. That surfaced roads and streets do materially reduce such costs is proven both by common experience and scientific investigation. A comparison of operating costs reveals that such costs are reduced 19 per cent on intermediate and 34 per cent on high type roads as compared with costs on unimproved highways.

Advocates of the diversion of the gas and registration tax revenues argue that land taxes are high, and there exists a great demand for their reduction, while the motor vehicle fund is a large, easily collected and unresisted revenue. The trend of the relief of land taxes for highways will



Figures for 1931 are estimated.

Growth of Net Gasoline Tax Revenue, 1919-1931

Highways properly located and constructed return large dividends on the investment.

Land taxes have been relieved as the gas tax has rapidly taken the place of funds formerly furnished for road construction and maintenance by land taxes.

continue, if undisturbed, until the tax on land for such purposes becomes practically nil.

A study of state highway programs discloses that in 1923, 7.79 per cent of the income was derived from general taxation; by 1930 this had fallen to 1.31 per cent. In 1923 52.13 per cent of the total received for state highway funds was direct from motor vehicle users; in 1930 this percentage had increased to 82.09 per cent. Thus it may be readily seen that the revenue furnished by the motor vehicle user through auto fees and gas taxes has been the principal support for the development of our present highway system. It has enabled many of the states to match federal appropriations. More recently it has been extended for the improvement of county and other local roads, supplementing or replacing real estate and personal property taxes.

The gasoline tax, when used for purposes other than roads, is inequitable, because it places a second tax for such purpose on the vehicle owner who has already paid general taxes.

According to the National Automobile Chamber of Commerce, the automobile owner pays taxes amounting to 18 per cent annually on the average value of the vehicle during its lifetime, as compared with annual real estate taxes on urban land of 2.4 per cent and farm land of 1.6 per cent.

The motor car has long since ceased to be a luxury. It is a practical necessity as an essential means of transportation, and a vital factor in modern business. Motorists generally are aware that improved highways add greatly to property valuation, and that everyone shares in the dividends derived from better roads. These same motorists have, however, repeatedly waived this argument and voted special taxes on themselves with the proviso, however, that these funds be used for highway improvement. The motor vehicle is today by far the most highly taxed form of non-luxury property in the United States.

Gas tax diversion to purposes other than streets and highways encourages the habit with lawmakers to fall back on an inequitable expedient at the expense of sound principles.

The slightest diversion of gas tax revenue to purposes other that streets and highways will be the signal for a general scramble for the gas tax trough. The moment that the gas tax revenue is diverted from its original purpose no matter how commendable the object—the way will be opened to draw any or all state taxes from the gas tank of the motorist. If under so worthy an object as unemployment relief, the gas fund is invaded, the precedent will have been established, the sound policy broken and any or every tax use may demand a seat on the gas wagon. Permit this grab and the door will be wide open for future diversions with the result that governmental bodies must retrench on highway and street programs or discover new sources of revenue.

It is mandatory that the pledge to the motorists when gas taxes were imposed be safeguarded. This pledge was to the effect that these funds would be used only for the maintenance and improvement of the streets and highways over which these same motorists operate their motor vehicles. There is no fairness otherwise. The repudiation of this pledge penalizes the motoring public for the benefit of enterprises now being rightfully financed by general taxation.

Increasing the rate of gasoline taxes has been proposed as a method of replacing the highway funds diverted to other purposes. Such a course is in many localities dangerous. Oklahoma increased its tax rate 1 ct. in 1931 and collected less money than at the lower rate. Pennsylvania decreased its tax rate 1 ct. and collected more money than at the former rate.

At the present time no less than 13 different forms of taxes have been placed on the motorist:

State Registration Fees
State Gasoline Tax
State Personal Property Tax
State Driver's License Fee
State Registration Card Fee
State Certificate of Title
County Gasoline Tax
County Personal Property Tax
City Gasoline Tax
City Personal Property Tax
City Wheel Tax
City Driver's License
City Registration Fee.

Probably at no location are all such taxes levied, but this simply shows the trend toward motor vehicle taxes.

Diversion breaks faith with the motorist and the gas tax becomes just another sales tax. Such diversion is an abuse of the most equitable and easy method yet devised for financing highways.

Stabilization of highway programs and income are absolutely essential to the orderly progress of highway transportation. The road dollar will buy more construction value today than ever before, and probably more than it will buy for many years to come. Highways are not overbuilt—the need is nation-wide—trained highway departments are, together with completed plans, ready to proceed in an orderly manner, thereby assuring needed improvements without waste or delay.

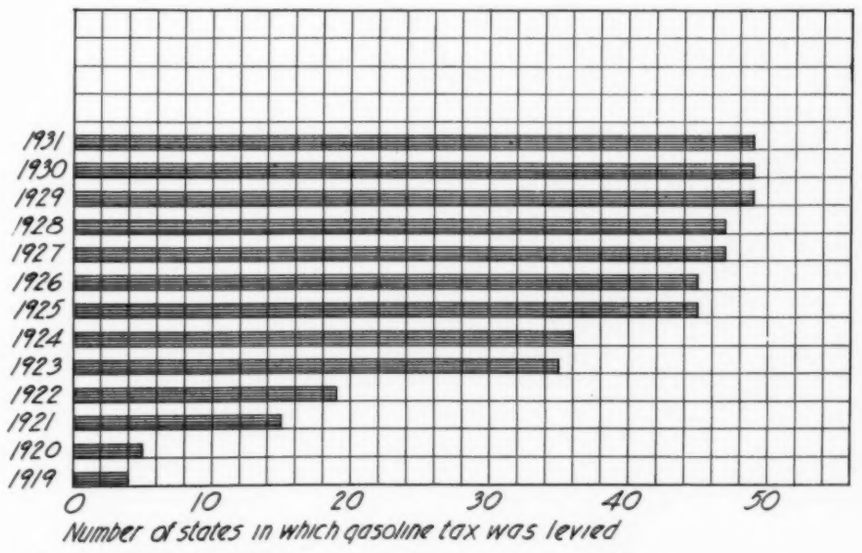
Diversion of gasoline tax funds breaks the backbone of the highway revenue. The rapidity with which the point of diminishing returns is reached makes attempts to restore this fund by increased tax highly dangerous.

The fact that we have today 26,000,000 motor vehicles is sufficient reason for the necessity of improved highways. Every dollar taken from the highway fund reduces the utility of the motor vehicle and therefore its value. Every dollar spent in highway improvement increases this value. Neither the highway nor the motor vehicle can be evaluated alone. Both must be weighed together and considered as a single transportation medium.

Detailed studies conducted and reported by the Bureau of Public Roads disclose that highway construction returns to labor as high as 91 per cent of each dollar expended in highway construction. The amount returned is dependent upon the type of improvement, but the average is approximately 85 per cent. In practically no other industry is the return so high. To divert funds means a reduction in highway programs, which in turn can only result in an increase in unemployment. To divert these funds for relief through organized charities means simply the maintenance of one person in non-productive activity while throwing out of employment one or more individuals from which the public receives a material benefit in improved transportation facilities.

Modern highway requirements demand a fixed income. Emergency diversions of this income throw the system into confusion, waste and delay.

Continued road building supports the industries engaged in construction, in the production of materials and machinery and sustains the automobile and truck industry. Gas tax diversion means the interruption of this support. Diversion of gas tax revenue causes unemployment.



In this analysis the District of Columbia is counted as a state.

Growth of the Method of Financing Higway Programs with Gasoline Tax Revenue.

RATES OF GASOLINE TAXES AND NUMBER OF STATES IMPOSING EACH RATE, 1919-1931

Prepared by American Road Builders' Association

Rate Per Gal. in Cents	Number of States Imposing Indicated Rate of Tax Each Year												
	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
¼	1	1	1	1	..	..	..	..	..	..	..	..	..
1	2	3	13	16	15	7	3	2	..	..	..	..	..
2	1	1	1	2	11	17	21	22	13	13	8	7	5
2½	..	..	..	..	1	2	1	1	..	..	..	..	..
3	..	..	..	..	8	9	12	9	16	14	9	11	11
3½	..	..	..	..	..	..	3	3	1	1	1	1	..
4	..	..	..	..	..	1	4	5	11	11	20	17	16
4½	..	..	..	..	..	..	..	1	1	..	..	..	..
5	..	..	..	..	..	..	1	2	5	7	8	10	11
6	..	..	..	..	..	..	..	..	..	..	3	3	5
7	..	..	..	..	..	..	..	..	..	..	..	..	1
Total	4	5	15	19	35	36	45	45	47	46	49*	49*	49*

*District of Columbia counted as a state.

Gasoline tax revenue is in many instances pledged for the payment of outstanding highway bonds.

Diversion of gasoline tax receipts to other purposes makes the payment on such bonds an obligation against general taxes with a possibility of increasing such taxes. Gasoline tax revenue is pledged for the payment of interest and principal on outstanding highway bonds in the following states: Arkansas, Delaware, Iowa, Louisiana, Michigan, New Jersey, North Carolina, Oregon, South Carolina, and West Virginia.

The most fertile field for tax reduction lies in the economies which may be effected in governmental administration.

The ease with which general funds may be augmented by the diversion of gas tax revenues makes this method preferred by the politician, rather than to put into effect economies in governmental administration.

The motorist demanded more roads, but at the same time created the gas tax to supply the revenue. Divert this revenue to a purpose foreign to its realm and the 26,000,000 motor owners of this country will check the flow of funds now forming the backbone of our highway program. It will become a discriminatory measure. When taxes become discriminatory they destroy the source of taxation and encourage evasion. Already such evasion has reached the point that, in many states, committees have been organized by responsible gasoline dealers and producers to assist the public authorities in investigating and trying to combat it. It is estimated by the American Automobile Association that in 1931 this evasion totaled $40,000,000 of highway funds.

Gasoline has become a most valuable commodity of trade for a new race of bootleggers and racketeers.

Large organizations of real estate owners in an effort to secure a reduction in taxes on real estate, have pointed to the gas tax as a ready source of revenue for purposes of general state and local administration. Before heeding such counsel, our legislators would do well to reflect seriously on the fact that, in the bonanza days of suburban development no group was more enthusiastic for roads than the real estate men who are now perfectly willing that there should be a road building holiday. Nor should they lose sight of the fact that, at the present time, motor vehicle property is paying an unusual tax, several times greater than the tax on urban and rural real estate.

IF we would have:

Increased land valuation
Lower motor vehicle costs
Reduced fuel costs
Work for the unemployed
Increased wealth and growth of our country
Improved business for local merchants
More profitable agriculture
Improved safety in motor travel
Reduced hauling costs
Increased tourist travel
Better mail deliveries
Improved fire protection
Additional recreation facilities
Increased healthfulness
Better police protection
Facilitated home building
Consolidated schools

Powerful business interests are in many instances encouraging our not unwilling lawmakers toward this diversion.

THEN—we must keep the gas tax revenue where it rightfully belongs—in the highway funds of the country.

A Discussion Concerning

ADHESION TENSION *in Asphalt Pavements*

Its Significance and Methods Applicable In Its Determination

By VICTOR R. NICHOLSON
Engineering Chemist, Bureau of Streets, Chicago, Ill.

Third Installment

Mr. Nicholson, in this article, has described two simple tests for adhesion of asphalt to aggregate, which can be run with apparatus available in any laboratory.
—Editor.

RETURNING to a consideration of the coarse concrete sand pavement mentioned in my two previous articles, it will be recalled, that it started to turn white and uncover the very first summer it was laid. A contributing factor to its behavior on the street may have been the soft asphalt used in the mixture. On account of the greater stability inherent in the mineral matter it was felt at the time the pavement was laid that a softer asphalt could be used and thus make the mixture more workable than is ordinarily the case. Therefore instead of a binder having 50 penetration as ordinarily used, the one used had a penetration of 65. Being laid as an experiment early in the spring, this pavement was inspected at short intervals of time during the following summer. After every summer rain storm it could be distinctly seen that the surface was being more and more uncovered. This action was not confined to the traffic lane but was just as noticeable where no traffic ever hit it. Therefore, it was apparent that the agency causing the whitening was the rain water falling on the pavement.

That this observation was true was verified in the laboratory, by making regular stability briquettes of the asphaltic mixture made with the coarse sand, together with others using colloidal sands. Briquettes of the rock asphalt were also made at the same time. After cooling the briquettes of the various mixtures were placed under a fine stream of water, which played on one spot of the briquette continuously for about two weeks' time. Ordinary Lake Michigan water was used and as it was the wintertime, the temperature of it was quite cold. In spite of the cold water, the coarse sand, the colloidal Potomac River and the North Carolina sand mixtures showed uncovering of the grains. The rock asphalt briquette made with material from Kentucky, showed pock marks or holes in the surface where the water impinged, not because the adhesion failed, but because the cohesion between the grains was too low. This method of testing, while verifying the results on the street, also showed the advantage of having a tight and impervious surface on the roadway. However, as a method for testing adhesion of asphalt to sand it was soon realized that unless the temperature of the water could be continually maintained at a given warm temperature, neither quick nor reliable results could be obtained.

Then I conceived the idea of dissolving the asphalt on the grain in its own weight of a solvent such as toluene or benzol, and subjecting the softened asphalt on the grain to the action of water in an Erlenmeyer flask. The original idea in doing this was to lower the surface tension of the asphalt sufficiently to cause uncovering of the sand grains in the presence of water. The asphalt which stayed on the sand grains in the presence of its own weight of solvent and the water was then considered to be more adhesive than in the case where it came off. While this is true, this hypothesis did not seem to cover or explain all the different behaviors of asphalt and sand which I have observed during my experience with this test. Therefore, the original hypothesis was changed to read as follows: Adhesion being a surface phenomenon, when asphalt is sticking well, part of it next to the grain will remain insoluble or be unacted upon by solvents, when this solvent is not present in a too great amount. In other words, the asphalt will be adsorbed on the surface of the mineral and thus make the bitumen stick better in the presence of water, than where the adhesion is not so great. It has often been noticed in my laboratory, that when asphalt is applied in a very hot mixture that it seems to extract much slower with carbon-disulphide than when it is put on at a lower temperature. Outside of this general observation, it is realized of course that this assumption cannot be directly proven, as the solubility of the asphalt on the grain increases with the amount of solvent used, so that after complete extraction of the sample with the solvent, there is no greater amount of adsorbed asphalt remaining on the grain in a sample in which the asphalt is sticking well, than where the adhesion is not so great. However, all the other data I have derived indicate this assumption to be true.

It can be seen that this reasoning follows along the lines of adsorption phenomena. It will be recalled that Dow in his test for adsorption value used a dilute solution of asphalt in carbon disulphide, which he allowed to seep through a column of sand to be tested. The sand removing the most asphalt from solution was therefore the most adsorbent. If the adsorptive value of the pure colloid present on the sand grain, is known or can be determined, it can be seen that this test can be used for determining the amount of colloid on a sand. As a general proposition, the sand containing the most colloidal coating will require the most asphalt to cover all of its mineral surface, and therefore each individual grain of

sand will be surrounded by a thicker film of asphalt, than where no colloid is present. However, this test was not intended to show how tenaciously the asphalt adhered to each unit of mineral surface. It only shows to what extent the colloid likes the asphalt in preference to the carbon disulphide. The method of adhesion testing I have proposed, on the other hand is based on the principle of how much asphalt in a given asphaltic mixture stays out of solution when adding comparatively small amounts of solvent. In other words, in order to make the asphalt stick, a certain amount of it must be adsorbed on the mineral grains.

On applying the water solvent test to a sample rock asphalt which had been sent to me as a year old material, it did not uncover, but the grains stayed black, even after one hour's agitation by hand. Subjecting a sample of the coarse concrete sand mixture already mentioned, to the same test, I was surprised to find that the mineral grains became bare within 10 minutes' time. Subjecting plant samples of our ordinary sheet asphalt to the same test, they showed the same results as in the latter mentioned case. The results with rock asphalt were rather startling, in view of the fact that the material contained only 7 per cent of bitumen of much softer consistency than that ordinarily used in sheet asphalt, and that the mineral matter was a sharp grained silica holding about 2 per cent of colloid. If the uncovering action had been due solely to the attrition between the individual mineral grains, the rock asphalt should have uncovered the most. That this uncovering action was not due to the wearing away of the grains in the coarse and ordinary sheet asphalt mixture will become evident later in this paper.

Following the suggestion of other members of the Asphalt Paving Technologists Society, an additional test using plain water heated to any temperature desired has been run parallel to the solvent test. As temperatures of 140° F. have been recorded in asphalt pavements it seems the test at this temperature will serve very well as a routine test. This does not prevent its use at any other temperature above or below that stated, and it may be desirable to use temperatures extending to the boiling point of water.

A practical demonstration of this test can be seen in the steaming of rock asphalts and other cold laid pavements. As is well known, it is often difficult to lay rock asphalt in cold weather, so in order to make the laying easier, the rock asphalt is heated in the pile or car, by the use of live steam, which actually comes in contact with the material. There are only a few varieties of rock asphalt that will stand steaming satisfactorily, for the heat and pressure of the steam removes the asphalt from the grains. Except in one case, I have not seen an artificial cold laid material that will stand this treatment without detriment to its quality.

Applying the plain water test at a temperature at 140° F. to the types of asphalt pavement previously mentioned, I found after one hour's agitation that the rock asphalt sample stayed covered, the coarse concrete sand mixture uncovered badly and the ordinary sheet asphalt pavement somewhat less than the coarse mixture.

After having worked for some time on the test described, I became acquainted with the work of Prof. F. E. Bartell at the University of Michigan, which represents years of labor on liquid-solid surface energy reactions. Based on data obtained by him, it becomes possible to show that the tests I have used are plausible from a theoretical and scientific standpoint.

It will be recalled from equation No. 5, in the second installment of this paper (April Roads & Streets), that one formula for adhesion tension is:

$$A_{12} = S_2K$$

Where A_{12} is the adhesion tension between the solid with surface tension S_1 and the liquid having surface tension S_2 and where K is a constant depending on the angle of contact made by the liquid with the solid. In case this angle is greater than zero then K is always less than 1, and in case the angle is zero then K is always greater than 1. It has been shown by Bartell in his study of adhesion tensions of petroleum crude oil to silica that the angle of contact in this system is always zero. Asphalt is also a petroleum product, and in the mixed spreads like a zero angle of contact substance, so there is no objection to believing that it also spreads on sand with a zero angle of contact.

It can be seen in Nellensteyn's curves, again shown in Fig. 1, that the higher the temperature of the asphalt the less the surface tension of the same. Comparatively little work, however, has been done to determine whether K in the above formula remains constant, independent of the temperature. Bartell, however, in "A Study of Energies of Immersion of Silica in a Series of Liquids," as published in the Journal of Physical Chemistry in March, 1932, calculates the relative heats of immersion of silica in a series of liquids, on the assumption that this factor remains constant. To quote from this article: "Since both S_2 and A_{12} decreased toward the same point in an approximately linear manner, and since at 25° C., $A_{12} = S_2K$, it follows that at any other temperature A_{12} must be K times as large as S_2 (at the same temperature) or in other words, K does not vary with the changing temperatures." This statement was made because the adsorption of a liquid by a solid and the surface tension of the liquid decreases linearly with increase in temperature, over certain temperature ranges. However, as intimated, since both adhesion tension and surface tension theoretically become zero at the critical temperature of the liquid, just before this point is reached A_{12} must be very nearly equal to the surface tension, so in that case, K would probably be different from what it is at ordinary temperatures. That the rate of change in surface tension will not remain uniform with increase in temperatures can be seen in Fig. 1 where the surface tensions of water decrease approximately linearly to 130° C. Even though a straight line relation at low temperatures for surface tensions of the bitumens has been assumed, it can be seen in the case of the two asphalts that this condition changes at about 125° C., while in the case of tar it changes at a temperature of 75° C. It remains to be shown of course whether the straight line temperature-surface tension relation holds at comparatively low temperatures for bitumens, but as no data has been shown to the contrary, this condition has been assumed to be true. Noting these differences in the liquids he used, Bartell stated that the heats of immersion be obtained while not absolutely correct, surely were relatively correct. As it is rather difficult in the laboratory to get water any hotter than 212° F., it is my belief that up to this temperature we will obtain satisfactory relative adhesion tension values, by testing the asphaltic mixtures, using hot water up to this temperature.

With these reservations, it can be seen that relative adhesion tension values can be obtained for a given asphaltic mixture in a series of flasks by changing the surface tensions of the asphalts on the grains, by means of hot water kept at different constant temperatures and noticing at what temperature the asphalt comes off the sand.

When surface tension data at low temperatures for asphalt becomes more available than at present, it can be seen that a pretty close approximation can be obtained as to what the adhesion tension in a given asphalt-mineral mixture is, in dynes per sq. cm., by using the tempera-

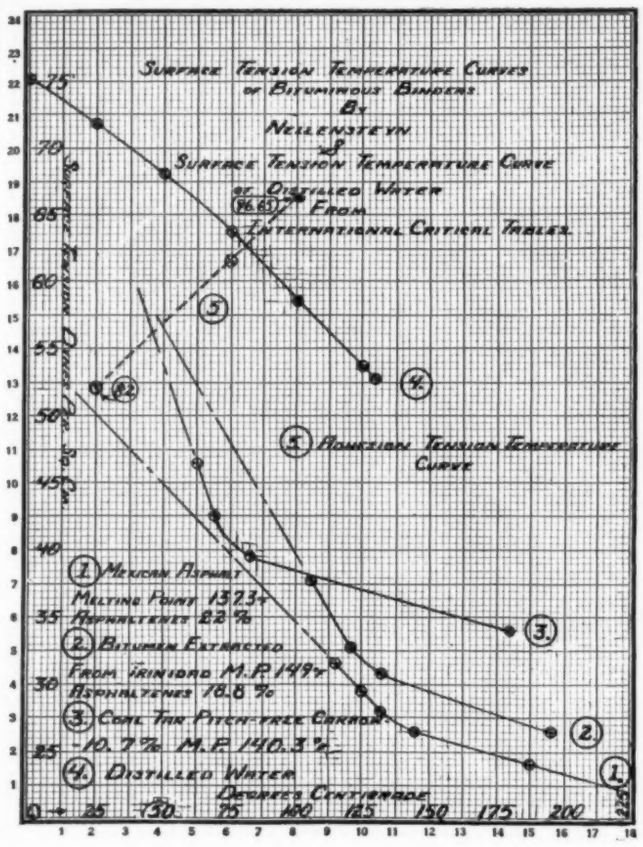

Surface Tension Temperature Curves of Bituminous Binders By Nellensteyn
Surface Tension Temperature Curve of Distilled Water From International Critical Tables.
Adhesion Tension Temperature Curve
1. Mexican Asphalt Melting Point 132°F Asphaltenes 22 %
2. Bitumen Extracted From Trinidad M.P. 149°F Asphaltenes 18.8 %
3. Coal Tar Pitch-free Carbon 10.7% M.P. 140.3°F
4. Distilled Water
Degrees Centigrade

Fig. 1

ture at which the asphalt comes off the grain to determine S_2 in the formula given.

Assuming that the slopes I have added to Nellensteyn's curves are correct as shown in Fig. 1, and that on using his asphalt No. 1, in the mixture, that the asphalt comes off the grain at a temperature of 75° C., then the corresponding surface tension of the asphalt at this temperature is 39.5 dynes per sq. cm. The corresponding surface tension for water at this temperature is 63.5 dynes per sq. cm. Assuming that the sand being tested has an adhesion with water at 25° C., of 82 dynes sq. cm., the surface tension of the water being 72 dynes at this temperature, K for water-silica is 82/72 or 1.14. Therefore the adhesion tension of water to silica at 75° C. is 1.14 × 63.5 or 72.4 dynes per sq. cm., which then corresponds to the adhesion tension of the asphalt-silica at 75° C. K for asphalt is then figured from 72.4/39.5 or 1.833. The surface tension of the asphalt at 25° C. again taken from the curve is 50 dynes per sq. cm., so therefore the adhesion tension of the asphalt to sand at 25° C. is 1.833 × 50 or 91.5 dynes per sq. cm., which of course is greater than that shown by water for the sand at the same temperature. It will be shown later on in this paper, that it is possible with a given mixture of asphalt, filler and sand to vary the amount of adhesion between the asphalt and the mineral matter by changing the temperature of application. Therefore in case the asphalt comes off at 25, 50, 75 and 100° C., in the different mixtures, the corresponding adhesion tensions using Nellensteyn's asphalt No. 1, figured in exactly the same way as above, would be 82, 86.5, 91.6 and 96.65 dynes per sq. cm. These are plotted in Curve 5 of Fig. 1, where it can be seen that it is a straight line. Therefore it is indicated that adhesion tensions vary directly as the temperature at which the asphalt comes off in the water test.

The theoretical basis for the solvent test is found in Curve A shown in Fig. 2, based on Bartell's studies of adhesion tensions of binary non-aqueous liquids for silica, and in Curve B drawn in by me, on the basis of some work I have done, on asphalt benzol mixtures. It can be seen from them that the adhesion tension-concentration curve for these binary liquids is not a straight line over the entire concentration range.

These curves can be explained with the assistance of equation 5B of the second installment (April Roads & Streets) which reads as follows:

$$A_{12} = S_1 - S_{12}$$

where A_{12} and S_1 have the usual meaning and where S_{12} is the interfacial tension between the solid with surface tension S_1 and the liquid with surface tension S_2.

It can be seen that the only variable present at the right of the equation is the interfacial tension. Therefore, the interfacial tension values responsible for results shown in Curve A and B, must correspond inversely to those in these curves as shown in Curves AIT and BIT. Whenever a surface or interfacial tension curve over the whole concentration range deviates from a straight line, we know that adsorption is taking place, that there is a concentration of either component of the solution at the interface. In Curve BIT there is an excess of asphalt at the interface the solution makes with the Silica. Adhesion tension has been defined as $A_{12} = S_1 - S_{12}$. It therefore follows that $A_{12} + S_{12} = S_1$. It can be seen, that a change in the value of the interfacial tension with the concentration at the solid-liquid interface is equal and opposite in sign to the corresponding change in adhesion tension. Written in algebraic terms, the rate of change of adhesion with the concentration is equal to minus the rate of change of the interfacial tension over the concentration, or

$$d A_{12}/dc = - d S_{12}/dc \qquad (a)$$

where A_{12} and S_{12} have the usual meaning and c is the concentration of the solution, in terms of solute.

The Gibbs equation for adsorption at an interface is

$$u = (-c/RT)\ (d S_{12}/dc) \qquad (b)$$

where u is the excess solute (asphalt) at the interface, R is the gas constant and T is the absolute temperature.

Substituting the value shown for $d S_{12}/dc$ as shown in (a) in equation (b), this equation becomes

$$u = c/RT \times d A_{12}/dc \qquad (c)$$

another form of this equation can be written as

$$d A_{12}/dc = u/c(RT) \qquad (d)$$

At any given temperature, the meaning of this equation is; that when adhesion tension increases with the

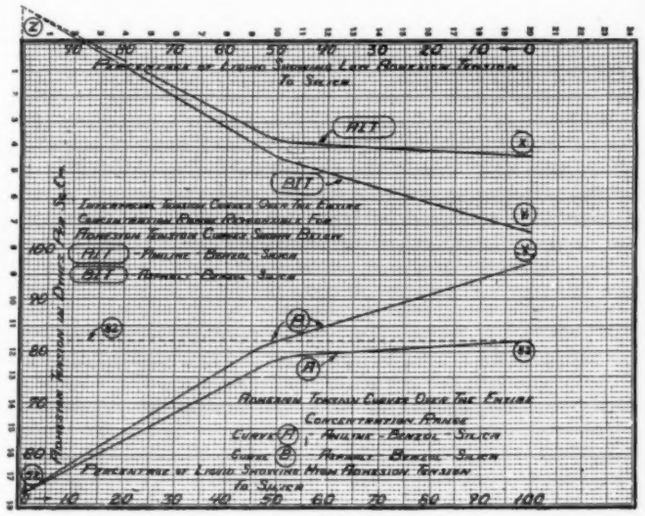

Adhesion Tension Curves Over The Entire Concentration Range
Curve A: Aniline-Benzol-Silica
Curve B: Asphalt-Benzol-Silica

Fig. 2

concentration, the excess of solute (asphalt) at the interface also increases with this concentration. Therefore when the concentration at the interface is the most, the adhesion tension is the highest.

In this manner, Bartell has established the relation between adhesion tension and concentration of solute at the interface (in other words the adsorption) as expressed in the classical Willard Gibbs Adsorption equation.

It will be remembered that the idea in using the solvent was to take advantage of any asphalt that remained insoluble at the asphalt-silica interface, so it can be seen from equation (d) that this assumption has been borne out in the above given mathematical treatment.

In order to determine the adhesion tension in a given asphalt-solid mixture, which is dependent on the adsorbed amount of asphalt necessary to prevent the water from displacing it on the sand grains, all that is necessary is to add different fractions by weight of asphalt present in sample, of a solvent such as benzol to a series of samples in some Erlenmeyer flasks. On allowing the different mixtures of asphalt-solvent to come to equilibrium either by shaking or standing, the softened mixtures are agitated with water, and the concentration of asphalt-solvent determined at which the asphalt just comes off. It is obvious of course that the sample which will stay covered in the greatest amount of solvent, therefore has the most adsorbed material on its surface, and is therefore the most adhesive of all the series.

It will be very interesting, as the basis for further study to determine what the different concentrations of solvent-asphalt correspond to in adhesion tension in dynes per sq. cm., for each variety of aggregate being used. It will also be interesting to ascertain whether these adhesion tension values remain fixed, independent of the aggregate being used. I have reason to believe that with a given aggregate that concentrations of 20, 40, 60, 80 and 100 per cent by weight of asphalt in solvent will always correspond to a certain constant adhesion tension. These values may be correlated up to the boiling point of water, with the plain hot water test, or can be checked with the Bartell displacement cell, and thus expressed in adhesion tension, in dynes per sq. cm. It will also be very interesting to determine whether the benzol-asphalt concentration necessary to cause uncovering, gives linear adhesion tension values or follows the inverse Freundlich adsorption isotherm.

I have found a great difference in the ability of the sand grains to stay black in 100 per cent concentration of solvent with asphalt. Therefore we can say that where it is sticking, there is also an excess of asphalt adsorbed on the grain, over against the case where it is not sticking so well.

On running the flask test, using either the hot water, or the solvent-water, at ordinary temperatures, it was soon found that the more vigorously the flask was shaken, the quicker the grains became uncovered. This showed that the velocity of the water in contact with the grains was a factor to be taken into consideration and standardized. The influence of this factor has also been observed on the street in the case of a cold-laid asphalt, where it had been laid under two different conditions. Thus, in the case illustrated in Photo 1, the cold-laid asphalt was laid on a curve carrying a large number of rapidly moving automobiles. The asphalt on the grains in this street uncovered very badly inside of six weeks due to the rainy weather and the rapidly moving traffic. The same kind of a pavement laid on a street where the traffic was not so dense or so swift, while uncovering, is doing so at a considerably slower rate. As was pointed out in the second installment of this article, when a liquid wets a solid, the system itself does a good deal of physical work in adhesional, spreading and immersional work, so in the uncovering of the grains enough outside mechanical work must be done to overcome this physical work done by the system itself. In view of these observations, it was decided to revolve the flask end over end at a constant given rate. The rotation was fixed so as to allow the sample to move up and down in the flask with no tendency to stay at one end, due to the effect of centrifugal force. The speed selected was about 39 rpm. brought about by a speed reduction from a motor running at 1725 rpm.

The rotating device is submerged in a water bath, which during the water test, is maintained at the temperature desired by means of a gas burner.

In preparing an experimental mixture for this test, I separate the mixture while cooling, by means of a spoon or spatula and pass it through a ¼ in. sieve, so as to have the sand grains loose and friable for test when cool. In case a sample of old sheet asphalt pavement or other fine asphalt surfacing is being studied, I warm them in an oven sufficiently to make the grains loose and friable after submitting them to the same treatment as before mentioned. On cooling, I weigh out 50 grams of the friable mix and put it in a 250 cc. Pyrex Erlenmeyer flask. This flask is so selected that it fits into the shaking machine I use. When using the plain water test, I heat water in a beaker to the temperature desired, and when ready pour into the flask 175 cc. of the warm water. After corking the flask it is given a few shakes by hand and the air pressure in the flask relieved by removing the cork. On replacing the cork, the flask is inserted into the shaking machine already described. During the water test, the temperature of the bath is continually maintained at the temperature desired. The flask with its enclosed sample and water, kept at the desired temperature is given a rotation lasting one hour. The flask is then removed and sample in the flask is examined through its bottom to see if the asphalt has been removed from the mineral matter, which ordinarily is very easily seen. In cases where this is not so apparent, but still present, the uncovered grains can be collected in one place at the bottom of the flask, by simply turning it by hand a few times, whereupon all the uncovered grains will congregate in one place. As already pointed out, since many asphalt pavements reach a temperature of 140° F., during the summer time, it seems desirable to run the water test at 140° F. as a matter of routine. However, for the purpose of testing for adhesion tension, different temperatures will have to be used, in order to find the temperature at which the asphalt just comes off the grain.

Using the solvent test, knowing the amount of bitumen in a mixture, it is easily calculated how much asphalt is present in the 50 gram sample used. Thus, if the sample shows 10 per cent of bitumen by analysis, then there are $50 \times .10$ or 5 grams of asphalt present in the sample.

For a long while after conceiving the idea of using a solvent with the asphalt and water, I used a concentration of solvent amounting to 100 per cent by weight of the asphalt present in the mixture. The consequence in most cases with sheet asphalt was that the asphalt invariably came off the grain. Then it became apparent that the asphalt did not stick as well in sheet asphalt as it did in rock asphalt, so then I used smaller fractions of solvent in comparison with the asphalt present, when I obtained results that showed that the asphalt was sticking better at lower concentrations. Therefore in getting relative measurements of adhesion tensions, I run a series

Fig. 3.—Flask Shaker

of 5 different samples, which have a concentration of solvent to asphalt of 20, 40, 60, 80 and 100 per cent by weight of same. In the case of a 50 gram sample containing 5 grams of asphalt, I weigh into the flask containing the mixture sample 1, 2, 3, 4 and 5 grams of solvent. These amounts in the binary liquid correspond respectively to 16.6 per cent, 28.8 per cent, 37.5 per cent, 44.4 per cent and 50 per cent of solvent in the mixture.

Running the test with the solvent, I weigh 50 grams of the loose friable mixture into the Erlenmeyer flask, and after weighing the flask and its contained sample, weigh in the required amount of solvent to correspond to the concentration of asphalt-benzol desired. The flask is now corked and asphalt on the grain assisted in dissolving by rotating or shaking the flask periodically by hand, or by allowing it to stand over night. The appearance of the softened asphalt in the flask changes with the amount of solvent present. In the case of 20 per cent of solvent, the grains remain about the same in size as without the solvent. On adding the 40 to 60 per cent amount of solvent, the individual grains tend to congregate into larger sized balls, the size of which depends upon the amount of solvent present. On the addition of 80 or 100 per cent of solvent by weight of asphalt, these balls break down and seem to form a continuous layer on the bottom of the Erlenmeyer flask. It is, of course, apparent that the larger concentrations of solvent with the asphalt soften the asphalt much faster than the lower concentrations. It has been my practice to allow the samples containing the 20 and 40 per cent concentrations to stand for at least 2 hours with occasional shakings by hand. When the asphalt is uniformly softened, cork in flask is removed, and 175 cc. of pure distilled water at a temperature of 70° F. poured into it. The cork is then replaced as before and inserted in the shaking apparatus and given an hour's rotation with the water. It is important that the temperature of the flask shall not deviate very much from the temperature specified. The reason for this, is, that the surface tension of the benzol asphalt solution will increase considerably if the temperature is lowered very much. On the other hand, if the temperature of the water exceeds the specified temperature very much, the surface tension of the solution will thereby be decreased considerably, causing the asphalt to come off the grain sooner than it should. The possible variation in temperature either way from 70° F., which will not cause a serious vitiation in results should not be more than 5° F. The liquid to be used should be a complete solvent for the bitumen. According to Nellensteyn, as given in his paper presented at the 6th International Road Congress held in Washington, D. C., last year, the following liquids are good solvents for bitumen:

Liquid	Surface tension, dynes., sq. cm.	Sp. Gr.	Vapor pressure	Solubility H_2O %	Adhesion tension to silica dynes/cm²
Carbon tetrachloride....	25.7	1.58	114.5	0.08	40.69
Cyclo-hexane	26.0	.779	95.0	0.00	42.13
Chloroform .	26.9	1.50	199.0	0.621	.....
Benzol	28.8	.878	34.0	0.072	52.43
Toluene	28.4	.881	34.0	0.00	54.70
O-Xylene....	29.1	.881	13.0	0.00	.....
Carb. disulphide	31.0	1.293	high	0.218	45.94
Pyridine.....	35.5	.972	....	100	.....
O-nitrotoluene	40.9	1.160	48.0	0.00	.....
Furfurol.....	40.7	1.15	....	9.00	.....
Nitrobenzene.	42.5	1.198	7.5	0.19	.....
Aniline	42.5	1.023	2.4	3.538	82.00
Quinoline....	44.7	1.09	low	6.00	.....

Vapor pressure is that property of liquids which governs the volatility of same. Liquids showing high vapor pressures in the before given table will volatilize much more than those giving lower values. The values heretofore given were those found in the International Critical Tables at a temperature of 25° C. Solubilities of liquids in water were those found in Van Nostrand's Chemical Annual. Adhesion tensions shown were those found by Bartell, and published in his papers.

The solvent I desired was one that was lighter than water, which was not too volatile nor too soluble in water, yet at the same time did not show a too high adhesion tension for silica. The selection of a solvent showing a too high adhesion tension for silica, has in my opinion, vitiated the results of tests for adsorption, appearing in the literature on asphalt during the last year. The idea in using a light solvent was, that when used together with the asphalt it would give a solution lighter than water so that if it did come off the sand grains it would come floating up to the top so it could be seen. In my opinion the very best solvent which will meet all the requirements I have enumerated is o-xylene, but as this is a rather expensive liquid I have selected the two next best solvents, namely: toluene and benzol. I have also used nitro-benzol which seems to make the asphalt come off the mineral matter more than any other solvent I have used, but for this study benzol was used exclusively.

It is interesting to note how the different amounts of solvent act in the flask being agitated. The mixtures containing 20 per cent of solvent stay loose, and as a

Fig. 4.—Plain Asphalt-Benzol Tests

rule do not give any evidence of sticking to the sides of the flask. When the concentration of the solvent increases there is a greater tendency for the asphalt to stick to the sides of the flask. The reason for this, probably, is that as concentration increases more liquid bitumen is present and as the mineral matter is saturated part of it must get over onto the glass. When the asphalt is sticking well to the grains it seems that the asphalt remains on the side of the flask to the end of the test. When the dissolved bitumen is not sticking very well, this coating will make itself manifest within a few minutes after the start of the test, but on continuing it, the coating gradually disappears, so that after one hour's agitation, there is often no evidence visible that it ever did stick. As a general proposition the asphalt seems to stick on the interior of the flask which has been used for successive determinations better than on a new flask. Flasks which have been dried in an oven, say at a temperature of 325° F., show a greater tendency for the asphalt to stick therein, even after cooling, then flasks which have been dried with a cloth. It is very necessary of course, that the flask after being used shall be cleaned very carefully by means of carbon-disulphide, water, chromate solution and ending up with a rinse of distilled water and grain alcohol. The flask is then dried with a clean cloth. After an hour's agitation with water, the sample softened with solvent is examined as before described under the hot water test. In case the flask is coated on the inside by the asphalt solution, at the end of the test, the sample is poured out into another clean flask and grains examined for uncovering. I have run many tests in which the asphalt solution seems to have a great affinity for the glass but on examining the mixture contained therein, I have found that the sand grains have uncovered badly. Using an amount of solvent by weight equal to that of the asphalt in the mixture, this test shows that the softened asphalt has been washed off much worse from the mineral matter than in the test where no solvent was used, even when the water test was performed at 200° F.

I have run these tests hundreds of times, but it is impossible to enumerate all of their results.

However, by preparing mixtures of 8 per cent plain paving asphalt with 92 per cent of such colloidal sands as those from the Potomac River, North Carolina and Atlanta, without any filler, sands in which gave as high adsorptive values as any of those mentioned by Dow, the results show that the asphalt came off the aggregate in the plain hot water test at 140° F. as well as with the solvent present to the extent of only 20 per cent of the amount of asphalt present in the mixture, no matter what kind of paving asphalt I used and no matter how hard or how soft it was. All of these materials require considerably more asphalt to cover them than a plain silica sand or that from Lake Michigan. Plain Lake Michigan sand can ordinarily be covered with 5 per cent asphalt, whereas it required 8 per cent with the above mentioned sands. All mixtures were made at a temperature of 325° F., using great care in the preparation of the mixture, in order to be sure that all grains were uniformly covered.

Preparing a sheet asphalt mixture from these sands, using 10 per cent of any variety of asphalt, 15 per cent of any kind of filler and 75 per cent of the before mentioned sands, the results in both tests were the same as, or worse than with plain sand without any filler.

Removing the colloid from these sands, with water and a slight amount of ammonia, according to method mentioned in Installment 1, drying the colloid-free sand, and applying 8 per cent of any variety of asphalt, the colloid freed sands remained covered in the water test at 140° F., using any asphalt, but in the case of oil asphalts came off the grain in the 100 per cent solvent test. The only mixture of this kind which stayed covered in both tests, was that containing fluxed Bermudez asphalt.

Making a sheet asphalt mixture of the colloid-freed sands using any of the oil asphalts but different fillers, showed that the character of the filler was a dominant factor in determining the adhesion of the asphalt to the mineral mixture. Thus, using these sands with a pure silica filler, such as crushed up Ottawa sand, all of the mixtures showed up about the same as with the plain sand in the water test at 140° F. Using an impure filler of silica, such as is sometimes used in the vicinity of glass plants, all of the mixtures washed off in both tests. Using an impure filler of limestone such as is commonly found in the middle west, practically all of the mixtures without regard for asphalt variety came off in both tests. The use of a clay filler gave miserable results in both tests regardless of asphalt used.

It is very evident from the foregoing tests that the presence of colloidal material such as is ordinarily present on sand has a pronounced influence on the adhesion of the asphalt to the mineral matter.

Applying the adhesion tests to limestone mixtures, I find that the purity of same has a profound influence on how the asphalt adheres. Even with pure limestone, oil asphalt does not stick as well as the Bermudez. Running these tests using crushed up marble of different degrees of purity I find that asphalt always sticks the best to the pure sample. This is in line with what has been found in Europe, in regard to limestone rock asphalt, where a purity of at least 98 per cent is strictly insisted on.

In the case of crushed silica from Wisconsin, I find that all asphalts stick in a mixture, in which it and the asphalt alone are present. It also sticks quite well in the case of the silica sand and the silica dust made from it, but does not stick so well in the presence of other fillers, with the exception of crushed Ottawa silica. On the other hand I also have samples of silica sand from Florida, quite devoid of colloid or adsorbed salts, to which the asphalt sticks very poorly. Prof. Bartell has found that water does not adhere to the same extent on all silicas. Thus the tripoli which he used in most of his works shows an adhesion tension to water of 82 dynes, while on the other hand a fine sand he tested showed only 74.10 dynes. The difference in the results may be due to some impurity present or may be due to the physical structures of the sand. However, in the case of the Florida sand even though it has been heated to a temperature of 1800° F., it still does not hold the asphalt.

In the case of granite from Wisconsin, I find this to be one of the most difficult aggregates to make asphalt adhere to. Granite from Stone Mountain, Ga., on the other hand holds the asphalt quite well. The Wisconsin granite on being crushed holds a fine white powder, which on being washed off makes the asphalt stick better. Even with this colloid removed, the asphalt does not adhere as it should. The sample of Stone Mountain granite I had, on the other hand, did not hold this powder, and besides seemed to be black in spots. It is known that the colloid in Wisconsin granite is feldspar, while this must be present to a less extent or is of a different nature in the Georgia granite.

In the case of lake sands, I have samples to which the asphalt sticks quite well, whereas other samples hold the asphalt very poorly. The difference shown by these sands is probably due to the location in the lake from which they come as mentioned by Dow. It is entirely probable that a sand coming from a quiet place in the

Photo 1

lake will contain more colloid than a sand coming from a stormy place. In the case of lake sand, as with the other sands, the character of the filler is an important factor in the adhesion of asphalt to aggregate, in a sheet asphalt made therewith.

asphalt is always applied to the aggregate in a hot state, so in order to take into consideration the effect of heat after weighing out the sample in the bottle, I melted up the 5-gram sample in the flask by allowing it to stand in an oven at 325° F. for about 20 minutes. Flask was then removed and asphalt made to cover as much of the bottom of flask as possible by rotating it by hand. On cooling, the 5 grams of benzol were weighed in as before, bottle corked and allowed to stand until the asphalt was in complete solution. Then on adding the water and agitating as before was surprised that two of the asphalts covered the sides, which had not stuck at all before. The sample of the California asphalt on the other hand stuck very poorly, followed by two Mid-Continental asphalts.

Noticing the effect of heat in the foregoing test, I reasoned why certain samples of lake sand uncovered so badly, was that it had not been heated high enough. It will be recalled that the temperatures used in making up the mixtures was 325° F. Therefore I made up a series of mixtures of lake sand with the different fillers and a given oil asphalt at different temperatures. The results obtained are given the accompanying Chart I.

It will be seen that as the temperatures are increased the asphalt sticks better with the Ottawa silica and Uvalde rock asphalt filler. However, it can be seen that

CHART I—LAKE SAND WITH 10 PER CENT OF ASPHALT AND 10 PER CENT OF DIFFERENT FILLERS

Temperature of mix °F	250				300				350				400				425			
Kind of filler.....	LS.	O.S.	GD.	UV.	LS.	O.S.	GD.	UV.	LS.	O.S.	GD.	UV.	LS.	O.S.	GD.	UV.	LS.	O.S.	GD.	UV.
Water test at 140 F...	u.	u.	u.	s.	u.	s.	u.	s.	s.	s.	u.	s.	s.	s.	s.	s.	OK.	s.	s.	s.
	c.	c.	c.		c.	c.	c.		c.		c.		c.							
Amount of solvent.																				
20%.....	u.	u.	u.	s	u.	s.	u.	s.	s.	s.	u.	s.	s.	s.	s.	s.	s.	s.	s.	s.
	c.	c.	c.		c.		c.		u.		c.									
40%.....	u.	u.	u.	u.	u.	s.	u.	u.	u.	s.	u.	s.	u.	s.	u.	s.	u.	s.	u.	s.
	c.	c.	c.		c.		c.		c.		c.									
60%.....	u.	u.	u.	u.	u.	u.	u.	u.	u.	u.	u.	u.	u.	s.	u.	s.	u.	s.	u.	s.
	c.	c.	c.		c.		c.		c.	c.	c.									
80%.....	u.	u.	u.	u.	u.	u.	u.	u.	u.	u.	u.	u.	u.	s.	u.	u.	u.	s.	u.	s.
	c.	c.	c.		c.	c.	c.		c.	c.	c.									
100%.....	u.	u.	u.	u.	u.	u.	u.	u.	u.	u.	u.	u.	u.	s.	u.	u.	u.	s.	u.	s.
	c.	c.	c.		c.	c.	c.		c.	c.	c.									

LS. denotes limestone dust.
Os. denotes Ottawa silica dust.
Gd. denotes glass dust.
Uv. Uvalde filler.

u. denotes uncovering of sand.
s. denotes sticking to sand.
c. denotes clouding of liquid.

Besides the influence of the colloids in the minerals, the adhesive quality of the asphalt as shown in Fig. 4, may contribute to its performance when combined with the mineral matter. Samples 1-5 inclusive counting from the left are 5 gram samples of different oil asphalts used in Chicago dissolved in 5 grams of benzol. These asphalts all pass the city of Chicago specifications. After solution of the asphalt in the solvent, it is shaken up with 175 cc. of cold distilled water as before. After one hour's rotation it is found that the asphalt solution did not stick to sides of the flask, did not emulsify, but came floating to the top. Flasks 6 and 7 are respectively Trinidad asphalt and Trinidad A. C., submitted to the same test. They formed water in oil emulsions. No. 8 is a sample of sludge asphalt I had in the laboratory. It formed an oil in water emulsion. Flask 9 is Bermudez asphalt which stuck to sides of flask and stayed black. It showed no evidence of emulsification. No. 10 is ordinary road tar, which acted very similar to Bermudez asphalt.

The results with the oil asphalt did not seem to check the results on the sand grain so I tried to reason out what was wrong with the above test.

It will be recalled that the asphalt samples were weighed out in a cold state and then dissolved while cold in the cold Erlenmeyer flask. The Binder in a sheet

even though the asphalt is applied at a temperature of 425° F., in mixtures containing silica-glass dust and limestone dust the binder does not stick very tenaciously to the mineral mixture. This chart also gives a good basis for evaluating the fillers, in the order in which they

Photo 2

promote adhesion of asphalt to aggregate. Thus it can be seen that asphalt sticks best at a larger concentration of solvent in a mixture containing silica dust filler from Ottawa, followed by the powdered Uvalde rock asphalt, the limestone dust and lastly the silica-glass dust.

The results with the Ottawa silica dust were rather interesting, in view of the fact that Dr. Wilhelmi, in a German article on "A Study of the Adsorption Values of Stones Used in Street Construction," has shown that silica in powdered form is the least adsorptive per unit of area, of all the stones he has studied. This study was performed with the use of the asphalt solution similar to that which Dow used. It is my opinion that different conclusions would have been reached, if in the measurement of adsorption, the influence of heat on the asphalt and mineral had been taken into consideration.

A general criticism of results in the chart, is that, on account of the hot temperature the asphalt was burnt onto the sand. While this may be true of a plant mixture in which the asphalt is put on at this temperature, still in my case mixture was brought up to the temperatures indicated, and after mixing started to cool right away. A plant mix on the other hand would cool much more slowly and would probably burn on account of the prolonged heating. In order to attain adhesion, I am opposed to the use of excessive temperatures.

The only reason for using the high temperatures was to study the influence of heat on the adhesion of asphalt to mineral matter, and is not recommended for general use in the manufacture of asphalt surfacings in the asphalt plant. The samples of mixtures I used made at these temperatures had no more adsorbed material present on the grains after extraction than was found in the samples made at lower temperatures.

It will be recalled that the formula for adhesion tension is $A_{12} = S_2K$. I believe it will be seen from results shown in Chart I, that if the concentration of benzol-asphalt, at which the asphalt comes off the grain is any criterion of adhesion tension, then K is not constant for the asphalt used, independent of the temperature of application. It can be seen that it increases as the temperature of application in a mixture goes up. Therefore K in a sheet asphalt pavement composed of a uniform mixture of sand, asphalt and filler, will only be constant in mixtures which have been subjected to exactly the same heat treatment in the mixer and before the time of laying.

Another variable which had to be taken into consideration was the amount of asphalt present in the mixture. Thus it can be seen in Chart 5 that a mixture of lake sand with 10 per cent of limestone dust and 10 per cent of asphalt mixed at a temperature of 350° F., does not have a high degree of adhesion. Can the adhesion be improved by the use of different amounts of asphalt over what had been used? The results of these tests are shown in tabular form in Table I. Asphalt used was the same as that used throughout in all other experiments.

TABLE I—LAKE SAND WITH 10% OF LIMESTONE FILLER WITH DIFFERENT AMOUNTS OF ASPHALT APPLIED AT 350° F.

Amount of Asphalt:	9%	10%	11%	12%	13%
Water test at 140° F.....	s.	s.	s.	s.	s.
Solvent test using:					
20% by weight of asphalt	s.	s.	s.	s.	s.
40% by weight of asphalt	u.	u.	u.	u.	u.
60% by weight of asphalt	u.	u.	u.	u.	u.
80% by weight of asphalt	u.	u.	u.	u.	u.
100% by weight of asphalt	u.	u.	u.	u.	u.

Where u as before means uncovering and s means sticking.

It can be seen from the above table that it does not make any difference how much asphalt is used, the adhesion tension values obtained are always the same.

Running companion series of tests to the above, but using the colloidal sands from Potomac River, North Carolina and Atlanta, the comparative results using different amounts of asphalt showed the same results as given above.

Other tests I have run show that the penetration of the asphalt has a marked influence on how it will adhere to a given aggregate. The harder an asphalt, the better it will adhere to a given mineral aggregate, when applied at a suitable temperature.

Noting the influence of heat on the adhesion of asphalt to sand, it was very interesting to see how the so-called fluid types of binders such as cut-backs, emulsions and road oils would adhere to the mineral matter.

In the case of emulsions, it is not until just recently that an emulsion was available that could be mixed with a regular sheet asphalt mineral mixture. Using such an extremely slow breaking emulsion in proportions to give 10 per cent of pure bitumen, 10 per cent of limestone dust and 80 per cent of lake sand in a dry state, a mixture was prepared cold, and allowed to dry out by standing in the room for a month at air temperature. Sample of it was then subjected to the water washing test. Asphalt came off the grains at room temperature.

A sample of sheet asphalt, made with a cut-back asphalt at the same time as the emulsion type and in the same proportions as before stated, stood the washing test at 100° F., without uncovering but came off the grain at 120° F.

A popular form of surfacing material on certain types of roads, is an application of road oil. This is applied both as a surface treatment and as mixed in with the road material. Therefore, I thought it would be interesting to see how this material would stand the tests I have described. Therefore, I heated up a regular sheet asphalt mix, as before, composed of 80 per cent lake sand and 10 per cent limestone dust and mixed the minerals with 10 per cent of road oil at a temperature of 120° F. On allowing to cool the water test was applied to same. Bitumen came off the grains very badly at room temperature. Sample had not been allowed to age, as it would on the road so it would be very interesting to run this test on the aged material. It has been noted by Clarke, in extracting the asphalt from the Alberta sands, that when the sand is allowed to age, it is almost impossible to remove the asphalt from the grains in the treatment he uses. Whether this condition would hold true regarding road oil, is still a matter of conjecture. All the road oil we have applied in Chicago has been done by means of a spreader, which gave a fairly thick mat of bitumen on the roadway. The washing off action is thereby minimized, whereas in a mixed in place project, it would be increased to a large extent.

Applying these tests to the limestone rock asphalts, such as those from Texas, Sicily, Germany, and France, samples of which were available I find that the asphalt is sticking in the asphalt solvent test, even up to a concentration of solvent to asphalt of 100 per cent. It adheres equally well in water at a temperature of 212° F. This applies equally well to Alabama rock asphalt, such as we have tried in Chicago recently, after an addition of about 5 per cent of oil asphalt. These limestone rock asphalts are very pure materials consisting almost entirely of a pure calcium carbonate mineral.

Applying the tests to silica rock asphalts, such as found in this country, I find that the time which has elapsed since the material was quarried and milled has a great influence on the ability of the asphalt to stay on the grain.

Photo 3

Thus a freshly milled rock, such as that obtained in Kentucky, will show uncovering of the grains, whereas the same after it has been aged for some time, and perhaps even been turned over a few times in the pile, shows that it is sticking perfectly in both tests even at a temperature of 212° F. in the water test, and at a concentration of solvent of 100 per cent, in the solvent test. These different behaviors can of course be readily understood, when one considers, that some fresh surfaces must have been exposed on crushing the stone. These surfaces must have a chance to cover up with asphalt, before sample will show that the asphalt is sticking perfectly. In case a rock asphalt shows uncovering, it is well to heat it for 20 minutes in a closed can in an oven at 325° F., after which it should be tested. If it still persists in uncovering, we know that the asphalt is incapable of sticking in the system.

I have samples from only three quarries in a certain district which have proved very good in this test, and so far have not been able to find any silica rock asphalt from any other part of the country, in which the asphalt sticks as well as in the material from this district.

It is my belief that the adhesion of the asphalt to the aggregate in any cold-laid pavement should be as perfect as possible, for being more or less an open pavement, especially right after laying, it is subjected to a much greater emulsifying action than a tight pavement such as a hot laid and compressed pavement containing filler.

From a resumé of the results, the bitumen in rock asphalts seems to show much better adhesion to the aggregate, than is the case between the asphalt and the mineral matter in sheet asphalt.

This then probably accounts for the fact that even though a cold laid natural rock asphalt shows only 7 per cent of bitumen and in many cases a voidage content of over 15 per cent, in a fully compressed state, and is permeable to water at the start, still the pavement seems to last, as can be seen in some of our rock asphalt pavements laid here in Chicago, some of which are at least nine years old. Had a sheet asphalt been laid with only this amount of bitumen in it, it would have ravelled out of place long ago.

As to the reasons for the results with the laboratory prepared mixtures, there is the possibility, of course, that all of the mineral aggregate in the beginning was not covered with asphalt, which may be the case in some instances. Still it can be seen in the last tabulation that even though an excess of asphalt was used in a mixture, the behavior under the tests was the same. I have also taken samples from our asphalt plant mixer, after 1 minute's mixing, 5 minutes' mixing and 10 minutes' mixing, and I have found that the part that had been mixed 10 minutes did not show the asphalt to be sticking any better than the one which had been mixed for only 1 minute.

Another purely theoretical reason, which has not been definitely established yet, is the amount of spreading wetting which occurred in the mixing operation. As was shown in the previous installment, asphalt applied by spreading wetting does together with the solid the least amount of work by itself, so unless the deficiency in this respect is made up by mechanical work in the mixer, the asphalt will come off relatively easy. The rule seems to be that the wetting phenomenon, which produces the least amount of work by itself causes a condition of adhesion that is also the easiest to remove.

Another reason proposed is that when a colloid is present, even though a sample is heated to the temperature used in the asphalt plant, some water still remains and thus prevents the proper adhesion of asphalt to mineral matter. That this is not the case, can be proven by igniting a sample of any of the colloidal sands in a furnace at 1000° C., and then allow the sample to cool to 325° F. and then add the asphalt. The colloids in this way have been prevented from taking up any moisture from the air. The tests for adhesion by both methods will be about the same as without the heat treatment.

Another purely theoretical reason to account for the behavior of some aggregates, is the age of the material, since it left the massive state. One theory of matter states in effect that when a material is freshly crushed it possesses a large number of unsatisfied attractions which on aging gradually become satisfied, and thus make the solid less attracted to a material like asphalt. I do not know of any work having been done to prove or disprove this statement so am only presenting it as matter of general information.

The main reason undoubtedly lies in the colloidal content of the mineral aggregates. These consist mostly in the case of the sands, of the hydrous oxides, of which series clay, alumina, iron oxide and silica are members. These materials have a strong affinity for water, which can be measured by immersing them in water and determining the heat of wetting. Even though these colloids are covered with asphalt, if conditions are right as for instance warm weather, when something else comes

Photo 4

along, such as water, which they like better than the asphalt, they shed the asphalt for the water. The material existing in Wisconsin granite is a potash feldspar, which is really the mother substance to clay, which it forms under the action of water. Feldspar surely likes water better than asphalt so that is the reason probably why this variety of granite suffers in this test. The objectionable impurities in limestone are clay, iron and alumina and silica in the order of their importance. Besides these reasons there are others probably due to the presence of certain adsorbed salts which the asphalt does not like.

A fair question to ask me is, how can I account for the fact that sheet asphalt, in which ordinarily the asphalt is not adhering with a high degree of adhesion tension, has lasted so many years and still is a popular pavement? The answer is, that sheet asphalt is so physically constituted that the water is kept out of the pavement, therefore the asphalt between the grains still sticks. It may uncover somewhat on the surface, but on account of the fact that water cannot get down into the body of the pavement, the bond between the asphalt and the sand grain, even though imperfect is not broken. In the case of many cold-laid pavements, the reverse is true, for at the start, at least, the water has an opportunity to get down into the pavement, and when the bond between the asphalt and sand is not good, pavement will be destroyed.

Another fair question which has been asked me is, why is it that rock asphalt from one district, in which the asphalt adheres well, still contains a colloid, whereas all other colloidal mixtures show poor adhesion between asphalt and sand? The only answer possible at the present time is that there must be something different in the bitumen-mineral system in rock asphalt, from that which is present in sheet asphalt.

Some pictures I have taken will illustrate the effect of lack of adhesion in an asphalt mixture, in a pavement laid therewith. Photo 1 shows an attempt to lay an asphalt-sand mix without any filler. After being down for six weeks during which time rainy weather prevailed most of it has disappeared, leaving the roadway as it was in the beginning, before surfacing was applied. A good deal of this sand had its bituminous coating so thoroughly removed that it looked as if someone had thrown plain sand on the roadway. Photo 2 shows an open stone mix in the process of decay, as the stone is becoming bare. Photo 3 shows a hole already formed in an open mix pavement laid on an impervious base. Photo 4 is another hole in the same pavement. The common pot hole, so often seen in many of our asphaltic macadam roads, is another example of failure due to lack of adhesion. I believe you will agree with me that good adhesion in an asphalt pavement, no matter what type it is, is a very desirable thing.

In this series of articles I have indicated the methods proposed and used for measuring adhesion of asphalts and liquids to aggregates, including a method devised by myself, and have tried to show that asphalt does not stick equally well to all aggregates.

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25,814,103 Motor Vehicles Registered in 1931

Motor vehicles registered during the year 1931 numbered 25,814,103. Owners paid registration and license fees of $344,337,654, according to reports from State agencies as collected by the Bureau of Public Roads, U. S. Department of Agriculture. This registration represents a decrease of 2.8 per cent from the 26,545,281 motor vehicles registered in 1930. Motor truck registrations were 3,466,303 as compared with 3,486,019 in 1930. The figures for 1931 do not include 172,250 tax-exempt official vehicles.

The total revenue of $344,337,654 derived from licenses, permits, etc., was allocated almost entirely for road building purposes and played an important part in the continuation of road construction. The allocation was as follows: State highways, $200,733,786; local roads, $70,043,625; payments on road bonds, $42,574,464; collection and administration, $19,688,604; other purposes, $11,549,697.

The total registrations and license revenue by states are as follows:

State.	Grand Total Registered Motor Cars and Trucks, 1931.	Receipts from Licenses, Permits, Etc.
Alabama	246,465	$ 3,379,392
Arizona	105,572	767,508
Arkansas	180,731	3,495,545
California	2,043,281	9,763,274
Colorado	308,458	1,910,741
Connecticut	336,040	8,259,542
Delaware	55,202	1,043,173
Florida	323,260	4,851,968
Georgia	320,840	4,256,553
Idaho	111,663	1,909,363
Illinois	1,612,770	18,426,497
Indiana	862,672	6,332,101
Iowa	748,438	12,539,613
Kansas	559,176	6,059,910
Kentucky	327,326	4,842,108
Louisiana	263,050	4,549,244
Maine	188,238	3,184,091
Maryland	325,372	3,497,807
Massachusetts	840,190	7,000,306
Michigan	1,230,980	21,821,290
Minnesota	720,401	10,784,845
Mississippi	183,650	2,421,287
Missouri	752,805	10,140,429
Montana	127,166	1,499,492
Nebraska	416,131	3,742,401
Nevada	32,168	388,327
New Hampshire	111,510	2,257,459
New Jersey	869,867	15,891,204
New Mexico	81,325	1,248,097
New York	2,297,249	41,877,611
North Carolina	428,737	6,164,549
North Dakota	171,293	1,799,120
Ohio	1,710,625	12,818,705
Oklahoma	482,725	5,857,107
Oregon	278,225	6,940,504
Pennsylvania	1,741,942	31,607,172
Rhode Island	137,878	2,272,879
South Carolina	203,719	2,790,008
South Dakota	193,025	2,808,172
Tennessee	350,520	4,580,685
Texas	1,297,301	13,994,647
Utah	108,958	828,303
Vermont	83,877	2,355,913
Virginia	379,227	6,159,257
Washington	420,878	7,623,570
West Virginia	253,308	4,519,763
Wisconsin	754,249	11,724,995
Wyoming	62,101	727,667
District of Columbia	173,519	623,460
Total	25,814,103	$344,337,654

HIGHWAYS IN GREAT BRITAIN—In 1930 Great Britain reported highway mileage as: Class I roads, 26,417 miles; Class II roads, 15,924 miles; Unclassified (of minor importance), 134,915 miles. About one-quarter of the unclassified roads are residential streets in towns and urban areas. About 90 per cent of Great Britain's roads are built of some form of macadam. Motor vehicles registered on Aug. 31, 1931, comprised 1,076,128 passenger cars; 86,208 buses, coaches and taxis; and 344,207 trucks. Approximately 87 per cent are in England proper.

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HIGHWAYS IN ITALY—It is estimated that there are 105,637 miles of roads in Italy, of which 12,873 are national, 26,443 provincial, and 66,223 city or suburban. Divided by types they are: macadam, 76,060 miles; improved earth, sand-clay and gravel, about 19,014 miles; all others (including concrete, granite blocks, and asphalt and bituminous surfaces) about 10,563 miles. There were 301,407 motor vehicles registered on July 1, 1931. These were composed of 217,210 passenger cars, 10,501 buses and 73,696 trucks.

FITTING ROAD *Improvement Practices To* Traffic Demands

By P. M. TEBBS

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TRAFFIC demands maximum highway service for least cost. The problem is divided into two phases—how to determine what to build, and how to build it. We will consider the first phase.

No highway system can be worked out economically without a thorough knowledge of the traffic and, therefore, a comprehensive traffic survey is fundamentally necessary.

The basic present-day practices in the inauguration and upkeep of highway improvements are a result of merged economic and social demands and a development of experience and expediency.

Localized responsibility within narrow territorial limits such as our Pennsylvania townships having inadequate resources for required expenditures in the sparsely settled sections, became intolerable with respect to principal roads at an early date. Privately-owned toll roads companies encouraged by subsidy to furnish urgent necessities in highway transport were not fully successful. No effective solution of the difficulty appeared until federal and state governments combined to aid the counties and townships.

The one great question has been that of financing. It has been recognized that the cost of public roads is necessarily a public charge, but the distribution of the charge has been and still is a problem.

Road expenditures have always been considered in a different light than costs of civil government, national defense, or education. *It has been considered that road expendiures are for special benefit and that identification of interests benefited indicates proper assessment of costs.* This assessment is necessarily governed by the limitation of ability to pay or willingness to accept tax burden. So the realty and personal tax funds are supplemented or superseded by payments from road users, and in the interest of consistent development there is, in limited scope, encouragement from the national treasury.

There has been general approval of the idea that the principal highways are a direct responsibility of the states, and the trend of opinion appears to be that the responsibility of the states should be extended to cover the general field of highway transport. There is almost unanimous agreement that the principal sources of revenue for the financing of state highway improvements are properly provided by motor license fees and liquid fuels taxes. Since the road users constitute the majority of the voting strength, it appears that the limits of these charges are fixed less by ability to pay than desire for benefit. The conclusion is that *when service within reasonable limits is demanded by traffic, it is deserved, since traffic pays the bills.*

In past years, the financing of highway improvements has often been taken care of by bond issues. During the years when the use of motor vehicles was rapidly increasing, there was very little objection to mortgaging the future within reasonable limits. At that time, when inadequate road facilities were responsible for large annual losses to road users, when currently available funds were insufficient for required expenditures, and when rapid increases of revenues were anticipated, borrowing from the future seemed sound. Now that the annual increase in the number of motor vehicles is small, and the prospect of surface replacements, as well as maintenance in the approaching years loom large, there is less justification for issuance of bonds, and good business practice points to the "pay as you go" method of financing.

In highway administration it is not always possible to plan and build for greatest economy in the expenditure of road funds. The consideration of economy for road users is a fundamental responsibility of highway administration. When the need of improvement is greater than can be financed at once, some compromise is desirable between economy in road expenditures and economy in operation costs to the road users.

For instance, if a fund of $10,000,000 were available for a construction program, and we consider alternately plans for constructing macadam at $27,400 per mile and reinforced concrete at $31,640 per mile, we would be anticipating either 365 miles of macadam or 316 miles of reinforced concrete and 49 miles of unimproved road.

Taking into account the costs to the users of the roads computed on the annuity basis, the comparison of total annual costs would be as follows:

Assumptions: (1) Annual average daily traffic 500; (2) Interest rate 4¼ per cent; (3) Bituminous surface

EDITOR'S NOTE

In reading this article one must remember that the various cost of construction, reconstruction, and maintenance figures given are those peculiar to Pennsylvania. In following the method described one should use figures and specifications applicable to the particular state, county, or territory under consideration. One jurisdiction may charge traffic lining and use of trucks or other equipment in the maintenance figures while another jurisdiction may not. One section might charge oiling to annual surface maintenance and another section charge it to reconstruction. Where periodic maintenance leaves off and reconstruction begins is not a clear line of demarcation.

The bituminous surface treated macadam of Pennsylvania is a three or four course pavement at least six inches in depth. The lower five or six inches is a two course water bound macadam on which is placed a bituminous binder course followed by spreading stone chips. The name should not cause one to confuse it with a low cost road.

treated macadam construction at $27,400 per mile; including, (4) Surface at $15,900 of twenty-year life with resurfacing at $9,000 at end of ten years; (5) Grading and drainage at $11,500 with forty-year life; (6) Reinforced concrete construction at $31,640 per mile; including, (7) Surface at $20,140 of twenty-year life; and, (8) Grading and drainage at $11,500 with forty-year life.

(9).—COMPARATIVE ANNUAL MAINTENANCE COSTS

	Earth	Bit. S. T. Mac.	Rein. Con.
General maintenance	$500.00	$500.00	$400.00
Surface treatment	100.00	240.00	.....
Total	$600.00	$740.00	$400.00

(10) And operating cost reduction for improvement of earth road to reinforced concrete and to bituminous surface treated macadam alike $10.00 per year for each vehicle of annual daily average.

ANALYSIS

Ten million dollars to finance improvement of

364.96 of bituminous surface treated macadam at $27,400 (say 365 miles)

316.05 miles of reinforced concrete at $31,640 (say 316 miles)

Comparative Annual Costs of:

Fixed Charges	365 Mi.B.S.T.M.	316 Mi. R.C. and 49 Mi.Earth
40 yr. capitalization	365x$11,500x.0524	316x$11,500x.0524
	$219,949.00	$190,421.60
20 yr. capitalization	365x$ 6,900x.0752	316x$20,140x.0752
	$189,391.20	$378,590.85
10 yr. capitalization	365x$ 9,000x.1248	
	$409,968.00	
Total fixed charges	$819,308.20	$669,012.45
Maintenance charges	365x$740	316x$400 49x$600
	$270,100.00	$126,400.00 $29,400.00
Total road costs	$1,089,408.20	$824,812.45
Diff. in operation costs		49x$500x$10.00
		$245,000.00
Total comparable cost	$1,089,408.20	$1,069,812.45
Difference		$19,595.75

Being in favor of 316 miles of reinforced concrete and 49 miles of earth from the standpoint of economy, by such a small amount that the annual costs may be considered equal, for all practical purposes.

Here is a problem that every highway engineer must face. Shall we use the type involving higher initial cost? If he were planning the improvement of a trunk line system of 3,000 miles, for an annual construction budget of $10,000,000, at the time he could have completed the 300 miles with the lower cost type, there would remain 405 miles or 13.4 per cent of the system unimproved if the higher cost type were used. There are many other factors entering the problem, and all must be given due consideration in each set of circumstances. Traffic demands the completion of the trunk line system in the least possible time and upon this consideration only, the lower cost type should be used. Surface smoothness and losses incidental to the surface treatment of the lower cost type are factors not given values here and are difficult to evaluate, but are less favorable to the lower cost type. The answer to this problem is found in applying these same principles of analysis to the individual sections of the system, with proper values for cost, life, and maintenance. These are dependent upon materials, traffic and stability of subgrade. It is generally economical to use the lower cost type upon the more stable subgrade under the less severe traffic conditions. Some engineers undertake to design a highway from one city to another many miles apart, based upon a cursory traffic survey and considering the whole problem upon the same basis. More often than not, the conditions for design vary greatly. In Pennsylvania, traffic is found to be much heavier within five to ten miles of the cities than over sections between, and considerations of design must be treated accordingly.

In all phases of engineering, there is a critical relationship between cause and effect. The magnitude of total expenditures for road improvement and maintenance and the close connection between adequate highway facilities and public welfare impose upon the highway engineer due regard for economy and efficiency. The need for highway improvement is so extensive that consideration of ultimate costs is most serious even to the wealthiest states. It is imperative that each project be planned carefully not only as to first cost but with proper regard to depreciation and maintenance.

On the basis of expenditure from current funds, actual road costs are chargeable to depreciation and maintenance. Annual actual road charges may be explained as average annual depreciation plus average annual maintenance cost. For analysis or estimate of expenditures this simple method of determination is sufficient. For an economic study, however, there is significance in deferred expenditures, the best practice being to compute average annual cost of deferred expenditures in terms of annuity with the reciprocal of the formula

$$A = \frac{(1+i)^n - 1}{i}$$

Where A equals amount of annuity
n equals the number of periods
i equals simple interest per period.
1 denotes 1

A formula recently developed by Professor Agg and Professor Breed in committee for the Highway Research Board, modified slightly to correspond with the practice of the Pennsylvania Department of Highways in computing depreciation and maintenance charges, is as follows:

$$A = i\left[\frac{B}{(1+i)^m - 1} + \frac{C}{(1+i)^n - 1} + \frac{D}{(1+i)^p - 1}\right] + E + \frac{F}{P}$$

Where A is average annual charge
i is applicable annual interest rate
B is cost of grading and structures
m is period of charging off cost of grading and structures in years
C is cost of durable type surface or salvage value in surface
n is estimated life of durable type surface or term preceding resurfacing in years
D is cost of resurfacing (as appropriate)
p is period of resurfacing in years
E is actual annual general maintenance cost
F is the total amount of periodic maintenance costs, preceding resurfacing or between resurfacings
P is the period, in years, connected with the expenditure F
1 denotes 1

For the comparison of costs of different types of pavement, it is generally considered proper to add, to the amount of the annual charges indicated above, the equivalent of interest on the initial investment at the rate applicable to the agency responsible for financing.

The method that has been used for a number of years in the Pennsylvania Department of Highways is based on the formula for the "annuity which one will buy."

$$\frac{i}{(1+i)^n - 1} + i$$

which combines annual interest with the reciprocal of the formula for amount of annuity, the equivalents of this extended formula being directly available in tabular form in handbooks of accounting and finance.

The Pennsylvania formula with an example for illustration is as follows:

$A = Bb + Cc + Dd + M + N$

where A is average annual total charge

Example, One Mile of Surface Theated Macadam

B is grading and drainage cost $10,000.00

b is $\frac{i}{(1+i)^n - 1} + i$ for the period of years in which the grading and drainage cost if to be charged off ..... .07522 (4¼%, 20 years)

C is cost of durable type surface or salvage value anticipated in temporary or semi-durable type surface $6,000.00

c is $\frac{i}{(1+i)^n - 1} + i$ for the years of economic life of surface ..... .07522 (4¼%, 20 years)

D is resurfacing cost $10,000.00

d is $\frac{i}{(1+i)^n - 1} + i$ for the years period preceding resurfacing ..... .12483 (4¼%, 10 years)

M is average annual cost of general maintenance.. $500.00

N is average annual cost of periodic maintenance.. $240.00

$10,000 x .07522 =	$ 752.20 (3 retreatments at $800 in ten years)
6,000 x .07522 =	451.32
10,000 x .12483 =	1,248.30
	500.00
	240.00
	$3,191.82—Total of average annual charge

The fundamental measure of traffic is in a single lane.

The most conservative method of computing maximum traffic is based upon safe driving interval computed from braking distances. Braking distances vary with the square of rate of speed and are affected by gradient. Basis figures, for four-wheel brakes are six-foot braking distance for zero per cent.

Assuming the average of motor vehicles as the braking distance plus seventeen feet and multiplying the factor 5,280 over interval by speed rate per hour in fact the theoretical maximum capacity of one traffic lane is found to be 2,264 vehicles per hour at fifteen miles per hour on zero per cent gradient, 2,006 vehicles per hour at fifteen miles per hour on —2 per cent gradient, 1,821 vehicles per hour at ten-mile speed on —4 per cent, 1,703 at ten miles per hour for —6 per cent, and 1,600 vehicles per hour at 10 miles on —8 per cent.

Practically speaking the maximum carrying capacity of a single traffic lane is difficult to check, there being very few existing examples. There is a record, however, of 1,900 vehicles moving in a single line, in one hour, in the Holland Tunnel. This appears to verify theoretical calculations sufficiently to establish them for application in congested areas where there is segregated traffic under almost ideal control.

More generally interest in traffic capacity relates to two or more lanes with the complication of opposite direction of travel and of overtaking and passing.

An early analysis of the passing problem appearing in the Proceedings of the seventh meeting of the Highway Research Board indicated 1,320 vehicles per hour as a maximum capacity of the two-lane road with freedom for vehicles to overtake and pass others moving at a lower speed.

Later activity of the Highway Research Board furnished more extensive data. It was decided that traffic capacity is overtaxed when congestion occurs, and that congestion occurs when the number of vehicles reaches a total great enough to fill the road and make turning out impracticable. One minute is the minimum amount of time considered. With the above criterion, observations show that the two-lane road is frequently free from congestion with up to 1,000 per hour and the three-lane road is practically free from congestion with up to 1,600 vehicles per hour. No reliable indication of overtaxed capacity of a four-lane road under rural conditions has been secured.

Observation on two- and on three-lane roads was as follows:

ANALYSIS OF TRAFFIC

Based on All Traffic Counts for 5-Minute Intervals on 2-Lane Roads

No. of vehicles per 5 minutes	Rate per hour	Per cent of time congested under all conditions	Per cent of time congested Maximum per cent of traffic on way 50-60%	60-70%	70-80%	80-100%
50- 70	600- 840	0	0	0	0	0
70- 90	840-1080	8	6	13	13	0
90-110	1080-1320	33	42	43	53	0
110-130	1320-1560	73	78	100	67	80

Based on All Traffic Counts for 5-Minute Intervals on 3-Lane Roads

No. of vehicles per 5 minutes	Rate per hour	Per cent of time congested under all conditions	Per cent of time congested Maximum per cent of traffic on way 50-60%	60-70%	70-80%	80-100%
70-100	840-1200	0	0	0	0	0
100-130	1200-1560	10	20	4	0	0
130-160	1560-1920	21	33	18	40	0
160-190	1920-2280	53	71	90	100	0
190-220	2280-2640	80	100	100	100	40

Considering that some degree of congestion is to be tolerated at peak hours, approximate annual daily average traffic being four times the volume of maximum hour flow, working traffic capacity of roads under rural conditions appears to be as follows:

Width	Hour Maximum Capacity	Daily Average Annual Capacity
2-lane	1100-1320	4400- 5280
3-lane	2200-2300	8000- 9200
4-lane	4000-4400	16000-17600

Of the Pennsylvania state highways at the present time there are approximately 81 miles of 3-lane width and 40 miles of 4-lane width, principally within the areas of urban influence of Philadelphia and Pittsburgh, fairly consistent with the above capacity estimates.

A type of three-lane traffic road has been developed in recent years in Pennsylvania which has proven almost ideal for traffic control, and promises to vindicate the three-lane road from the charge of involuntary manslaughter.

A considerable mileage of Pennsylvania's three-lane highways is composed of two new 10-foot concrete lanes with a 10-foot lane of salvaged macadam in the center. The macadam lane has a crown of from two to two and one-half inches and the concrete supports the edges of the macadam so as to keep the maintenance charges relatively low. The contrast of macadam and concrete serves to segregate traffic to the outer lanes most effectively. Color, crown, and surface smoothness all appear to be contributing factors. These sections are readily seen to be almost free of the overlapping of traffic from one lane to the other by which free use of the center lane for passing only, is so often

obstructed. I recommend your consideration of this type of design.

I cannot conclude without giving you some idea of what Pennsylvania is doing to meet its present traffic demands.

The state highway system consisted of 13,560 miles on May 15, 1931, of which 10,448 miles were improved, leaving an unimproved mileage of 3,114 miles.

During Governor Pinchot's campaign in 1930, he pledged his best efforts to place approximately 20,000 miles of additional rural highways on the state system as a tax relief to the local communities. As soon as he took office, he caused legislation to be introduced, which proved to be quite popular and by practically unanimous vote, the legislature added approximately 20,285 miles of rural roads and 307 miles of city streets to the state highway system effective August 15, 1931. As a result, our state highway system now comprises 34,252 miles.

There was an immediate demand for the improvement of the rural roads in accordance with the slogan to take the farmer out of the mud. In order to meet these demands with the funds available, old standards were laid aside and the whole organization had to be trained anew for the task before it. Our engineers were called into conference and drew up tentative standards, specifications, and estimates for types applicable to the rural highway improvement program. After laying out a tentative program the men in the field started a thorough investigation of the individual projects and the most economical supplies of road building materials. Representatives of the testing laboratory then went to the field and made a check on the material situation submitting reports and recommendations as to satisfactory economic types. Due to the lateness of the season the work was undertaken with the forces of the department which permitted the state to launch upon a considerable unemployment relief program.

The minimum width of grading section adopted was 20 feet and the minimum width of improved surface was 10 feet, although there were very few sections less than 14 feet in width.

In general, the cost of these rural roads averaged $6,000 per mile. The types vary greatly according to the materials available. Pennsylvania's problem would be very much simpler were it blest with an abundance of local gravel throughout the state as Indiana is. Where gravel was available, it was used as a base course; slag, reddog, flint, napped field stone, crushed stone, etc., were also used. As far as practicable a base course of from six to eight inches of napped field stone was used since it proved to be economical and afforded by far the greatest amount of unemployment relief. The surface courses consisted of plain surface treatment for a single course highway of crushed stone or slag, heavy surface treatment with stone chips forming about a one-inch mat over the base course, or a semi-penetration about two inches in depth consisting of a commercial three-quarter inch stone penetrated with approximately one gallon on bituminous material, applied in two or three applications. This latter type is similar to the mixed in place retread without the manipulation. Naturally, we in Pennsylvania are working along the lines of some former experience and do not represent that our types are superior to those used elsewhere. In fact, we are now studying the low cost surfaces used by contiguous states and expect to obtain valuable information which will result in improvement of our types as well as further economies.

Notwithstanding a late start, Pennsylvania was able to complete 3,120 miles of highway improvement during 1931, of which 823 miles were low cost construction on the old system, 1,765 miles low cost construction on the new rural system and the remainder, 532 miles, consisting of Federal-Aid, replacement, and new construction of higher type. In addition to this accomplishment, according to figures disseminated by the federal government, Pennsylvania led all the states in highway employment for four months with a daily average of 24,500 men employed. The peak of such employment during 1931 was reached during the week ending December 26, when 28,383 men were employed. The mildness of the winter has permitted us to continue this work and last week the number of men employed on our highway work was increased to 30,360.

Acknowledgment.—A paper presented before the Eighteenth Annual Purdue Road School.

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A Bit of British Humor

The man who worked through his lunch hour rather than disappoint his public.—From "Brought Forward," by H. M. Bateman.

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STEEL PAVEMENT—The U. S. Assistant Trade Commissioner, Sam E. Woods, Prague, Czechoslovakia, reports in Foreign Highway News, that in the fall of 1931 a local steel company laid a short stretch of steel pavement in one of the busiest streets of Prague for the purpose of making tests with this kind of paving material. The pavement was constructed by covering a concrete base with steel plates. So far results have been entirely satisfactory as tests have shown that there is no more danger from slipping in wet and frosting weather with steel pavement than with other types. The apprehension that steel pavement would increase traffic noises has also been disproved.

Design and Lighting of Safety Zones

A PAPER concerned exclusively with safety zones constructed at street railway stopping points was embodied in the report of the Committee on Traffic presented at the 1932 convention of the American Road Builders Association. The paper follows:

The term "safety zone" is variously applied in different localities. In some cases it is used with reference to only zones structurally protected from the encroachment of motor vehicles; in others it is applied to loading points marked by movable stanchions placed upon the pavement; and in other instances to areas marked out

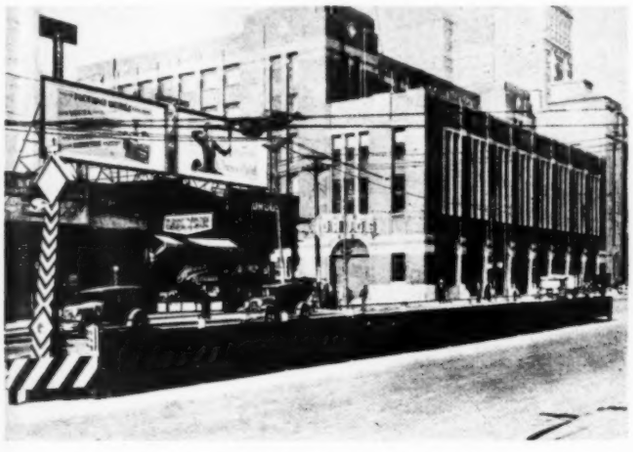

Fig. 2—Safety Zone at Detroit

on the pavement by paint lines or "mushroom buttons." The National Conference on Street and Highway Safety has defined as safety zones only those which are "plainly visible at all times," and since zones of the latter type are not always plainly visible, they will not be considered here. Nevertheless, it should be borne in mind that zones of this character have proved satisfactory in many localities, particularly on narrow streets where traffic is controlled and speeds are low.

To determine the extent to which safety zones are used in the United States, a questionnaire was sent to the railway companies in 98 cities, including all the 93 cities of 100,000 population or over. Replies were received from 83 cities. In 47 cities of this group safety zones of the raised platform, permanent post or temporary stanchion type were in use. The total number was approximately 3,500, and ranged from one each in Tampa, Fla. and Hartford, Conn. to 809 in New York City.

Thirty-five cities answered in detail as to the type of zone and character of lighting. These data are summarized below:

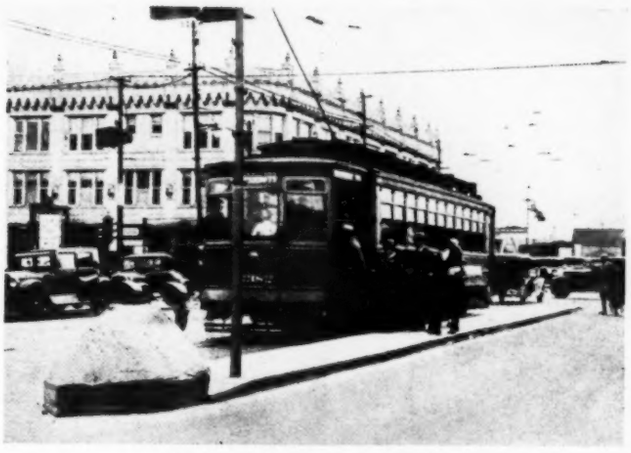

Fig. 1—Safety Zone at Chicago

TABLE I—SUMMARY OF TYPES OF CONSTRUCTION OF STANDARD SAFETY ZONE

General Type of Zone	Number of Cities Using Indicated Type of Zone
Raised Platform	23
Temporary Stanchions	6
Permanently Inserted Posts	4
End Abutment Only	2
Total	35

TABLE II—SUMMARY OF TYPES OF LIGHTING OF STANDARD SAFETY ZONE

Type of Lighting	Number of Cities Using Indicated Type of Lighting
Electric	21
Electric & Reflector	5
Lanterns	3
Reflector Only	1
Gas Beacon	1
No Lighting	4
Total	35

The average cost of safety zones was found to be approximately $600 for pipe stanchion zones, and $500 for concrete platform zones. This includes the cost of lighting installation. In the majority of cities, safety zones are built and paid for by the city, although in a few cases the railway company contributes a portion of the cost and in some instances pays the entire expense. In general, it is in the smaller cities in which the railway company participates in construction costs. A summary of the answers from the 36 cities replying to this question follows:

Fig. 3—Safety Zone at Los Angeles

TABLE III—WHO BEARS THE COST OF SAFETY ZONE CONSTRUCTION

Cost Borne By	No. of Cities	Per Cent of Cities
City Alone	29	63
City and Company	11	24
Company Alone	6	13
Total	36	100

TABLE IV—SAFETY ZONE CONSTRUCTION DETAILS

Detail	Most Generally Used Dimensions
Width	4 ft.—Greater widths are used where pavement permits, while lesser widths are frequently used on narrow streets.
Length	One car—Unless more are ordinarily stopped at one time.
Height of Platform	6 in.
Distance from rail	Depends on widths of cars. Cars ordinarily should not overhang zone. Where they do, clearance lines should be marked on the zone.
Distance between zone and curb	9 ft. 6 in.—one lane. (This is the minimum.)

In the design of safety zones such things as width, length, height of platform, distance from rail and minimum allowable distance between zone and curb are matters for individual decision. In all these, however, a fair degree of standardization has already taken place. Table IV shows the most generally used dimensions in each case.

Two other safety zone details, the end abutment and the lighting, have not been so well standardized. Both are, however, of considerable importance because of their relation to street safety. Properly designed, the first will tend to minimize the damage to colliding motor vehicles and their occupants and the second, by making the zone more visible, should act to reduce the number of collisions.

Of all the zones upon which information was received, that shown in Fig. 1, from Chicago, seems to have an abutment best designed to reduce the damage to colliding vehicles. The approach end is of concrete, V-shaped, with slightly bulging sides and sloping face.

The approach end of the safety zone in Detroit, Fig. 2, has a V-shaped prow, but with vertical instead of sloping face.

Analysis of the lighting arrangements on the more

Fig. 4—Safety Zone at Louisville

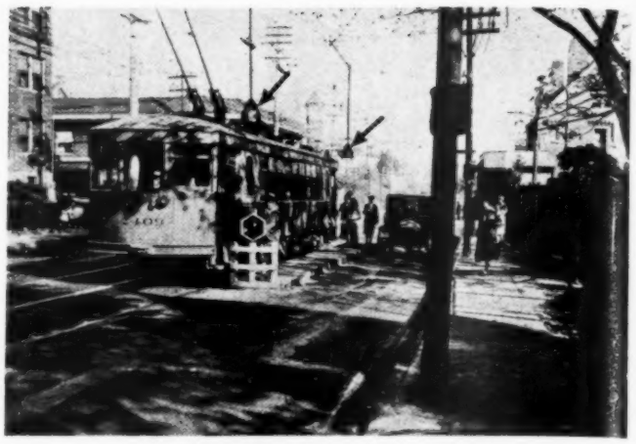

Fig. 5—Safety Zone at Cincinnati

recently installed safety zones shows that light serving four distinct purposes are used. These are:

1. Lights showing to approaching traffic mounted 9 to 12 ft. above the pavement.

2. Lights showing to approaching traffic mounted 3 to 5 ft. above the pavement.

3. Lights mounted so as to flood light the approach end of the safety zone.

4. Lights flood lighting the area in which pedestrians stand.

The first warns of the safety zone at a considerable distance, being visible over the tops of vehicles. This type of light is shown in Figs. 1, 2 and 4 near the top of the signal pedestals in each case.

The light which is placed near the level of the driver's vision again calls his attention to the potential hazard as he nears the zone. In Figs. 2 and 3 these are single electric lights. In Fig. 4 two flashing lights are used. In Fig. 4 a warning sign, constructed of reflecting "buttons" is used. In the Cincinnati zone, Fig. 5, the reflector is of A. G. A. hexagonal type.

Flood lights illuminating the approach end of the zone are shown in the Detroit installation, Fig. 2. Lights illuminating both the approach end of the zone and the platform are shown in the Chicago, Louisville and Cincinnati safety zones, Figs. 1, 4 and 5. The overhead suspended lights indicated by the arrows in the Cincinnati safety zone, Fig. 5, are used upon poorly lighted streets. Upon better lighted streets the pedestal mounted signal, very much of the type shown in Louisville, is used.

In addition, reflectors designed to pick up and return the light projected from the headlights of approaching cars are frequently used. Probably the most appropriate use of reflectors is at the outer edges of the end abutments, to define more clearly the limits of the zone. This is the use to which reflectors are put in Detroit, Fig. 2.

To increase the visibility of the safety zone, distinctive markings are customarily used. The Manual on Street Traffic Signs, Signals and Markings, of the National Conference on Street and Highway Safety, recommends that the approach ends of the safety zones be marked either by alternate black and white lines, 3 in. to 6 in. wide, sloping at an angle of 45 degrees, or by black and white checkerboard squares, each 6 in. to 12 in. on the side. In the safety zones in Figs. 2 and 3, this combination produces a striking effect and adds much to the visibility of the zone.

Should Army Control Federal Aid Highway Work?

Proposed Congressional Act Places All Federal Highway Expenditures Under Jurisdiction of Army Engineers

By V. J. Brown, C. E.
Associate Editor

THERE is a bill before the appropriations committee of the Senate entitled, "A bill to effect economies in the National Government." It is called H. R. 11597. As you read the following provisions catch the significance of the bill and gauge its effect on highway administration as you proceed. I shall quote a portion of the bill that particularly interests highway engineers.

Sec. 501. "There is hereby created at the seat of Government an establishment to be known as the Public Works Administration."

Sec. 502 (a). "The President is authorized, by Executive order, to transfer to the Public Works Administration, and to consolidate and coordinate therein, the whole or any part of all bureaus, agencies, offices, activities, and services, * * * having to do with the architectural, engineering, * * *, and/or purchasing activities of the Government relating to public works, * * * but no provision of this Act shall be construed to authorize any transfer, * * *, or change in the duties and responsibilities of the Chief of Engineers, * * *, or of the officers of the Corps of Engineers of the United States Army, * * *, all of which shall remain as now provided for by existing law."

(b) "The Administrator of Public Works shall utilize the services of the Corps of Engineers, or the officers of the Corps of Engineers of the United States Army whenever and wherever practicable in all other public works, construction, and activities." * * *

(c) "The Bureau of Yards and Docks of the Navy Department shall remain as now provided by existing law, and no provision of this Act shall be construed to authorize any transfer, * * *, or change in the duties and responsibilities of said bureau and the chief thereof, or the officers and engineers therein." * * *

(d) "All officers of the United States Army and/or Navy detailed as aforesaid to serve in the Public Works Administration shall retain their military and naval rank and succession and receive the compensation, commutation, and emoluments provided by law in the case of Army and/or naval officers of the same rank not detached from the regular service; and such payments shall be made out of funds appropriated for use of the Public Works Administration."

Sec. 503 (b). "The personnel on duty at the time of the transfer of any bureau, * * *, or service shall be transferred to and given appointment in the Public Works Administration, subject to such change in designation and organization and reduction in personnel, salary, classification, or otherwise, as the administrator may deem necessary."

Section 502 (a) transfers all highway engineering to the proposed "Public Works Administration." It will be particularly noted that the present activities of the Corps of Engineers is excepted from the consolidation.

Section 502 (b) then places federal highway work and the Bureau of Public Roads under the jurisdiction of army engineers.

Section 502 (d) it will be noticed does not in any way change the income of the army officers as at present provided; and this income is to be paid out of funds to be appropriated for use of the "Public Works Administration."

Section 503 (b) gives the chief of this proposed bureau complete authority to retain or release such personnel as now are directing federal highway work as he sees fit.

This bill should not be converted into law. Our present highway development is directly attributable to cooperative effort between the states and the federal government. The federal aid policy has resulted in a situation in which the federal government has given a push to the states and the states, likewise, have pushed the federal government for more funds. This cooperative action is the thing that has kept most of our states operating. To place jurisdiction of federal highway expenditures under the surveillance of army engineers would be to restrict this effort and thus curtail highway development.

Furthermore, Sec. 503 (b) breaks faith with the whole technical service of the government.

Centralization of authority over highway work would be a virtual ball and chain on highway development. This fact was recognized by Mr. T. H. MacDonald, Chief of the U. S. Bureau of Public Roads, when speaking before the Association of Highway Officials of the North Atlantic States, he said, "I can see no good reason, and some disadvantages, for the large states to take over all road administration at the present time, since it will be much better for the state highway departments in such states to occupy a position analogous to the position occupied by the federal government in its operation with the state highway departments." Highway development is accomplished through cooperation of varied highway authorities not through centralization of jurisdiction under one administration.

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Death Takes Col. E. M. Young, Leader in Cement Industry

Col. Edward M. Young, president of the Lehigh Portland Cement Co. and leader in the American cement industry for more than a third of a century, passed away quietly April 26, at his home in Allentown, Pa. As he had been seriously ill for some six months with heart trouble, the end was not entirely unexpected but it came as a distinct shock to his many friends nevertheless.

With Gen. H. C. Trexler and others, Col. Young organized the Lehigh Portland Cement Co. in 1897. He became secretary-treasurer of this company at its inception and later became treasurer. In 1908 he was elected a vice president and in 1925 succeeded General Trexler as president when the latter became chairman. His name appears conspicuously on the roster of the board of directors from 1897 to the time of his death, with an uninterrupted service record of 35 years during which period he missed scarcely a meeting of the board.

Colonel Young's genius was largely responsible for the remarkable strides made by his company. He saw it grow from an unpretentious office in Allentown and a small cement mill at Ormrod, a few miles distant, to a chain of 20 mills reaching from the Hudson westward to Washington state and southward to the Gulf, with offices in 25 principal cities. He was regarded everywhere as a leader gifted with stability and energy far beyond the limits of most men.

On the document calling the meeting in 1902 which resulted in the formation of the Portland Cement Association, Colonel Young's name, with that of his company, appears first on the list of signatures. Since that time his interest in the association and in the entire industry has never lagged. He was the first treasurer of the new organization and became its secretary in 1903. He served many terms as director, notably from 1904

to 1909 and from 1913 until his death. He served a second term as treasurer in 1922.

As a member of the executive committee and many important working committees at various times, Colonel Young enjoyed a unique distinction. Few men were as well known among the cement executives or as welcome on all occasions. He was an excellent story teller and dispensed wit and humor at many a meeting and dinner. He was in demand as a toastmaster and served the association and other bodies occasionally in that capacity.

Colonel Young had a pardonable pride in the Lehigh company and its achievements. The leadership of his employes in many lines of activity gave him keen delight. Success attained by the Lehigh organization in accident prevention work was one of his hobbies and he constantly encouraged others as well as his own men to higher endeavors. He was also a director in the Canada Cement Co., Ltd., and the Great Lakes Portland Cement Corp.

In addition to his cement affiliations Colonel Young found time to serve his neighbors and fellow citizens in many important capacities and it was said of him that he was a leader in all civic projects. He had been a member of the republican state committee of Pennsylvania for years and frequently served as national delegate, as had his father and grandfather before him. He served on the staffs of several governors and with the state militia.

He was born in Allentown and was in his 67th year. He was a son of Col. E. B. Young, of civil war fame, for whom the local G. A. R. post was named. He inherited the hardware business of M. S. Young & Co., which remains one of the leading retail stores of Allentown. At the time of his death he was also president of the Allentown Steam Heat & Power Co. and the Lehigh Valley Trust Co., the latter one of Allentown's largest financial institutions. He was one of the organizers of the Lehigh Valley Transit Co.

Colonel Young had served as president of the Allentown Chamber of Commerce and other civic groups. He was a trustee of Muhlenberg College and a member of many clubs and societies, including the Union League Club of Philadelphia and the Masonic fraternity. His widow, two sons, Robert Young and Joseph Young, and a daughter, Mrs. Edward Durham, survive him.

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Highway Employes' Safety Rules

The Minnesota highway department, as part of its safety work, recently issued a set of rules to its sectionmen and other employes who drive trucks and road machinery. Although two or three of them have special reference to road work, the rest of them are good rules for all drivers of motor vehicles so we publish them in full:

1. Be courteous at all times.
2. Be neat about your personal appearance.
3. Regulate the speed of your truck according to road and weather conditions. At no time must truck be driven faster than 45 miles per hour.
4. Slow down at road intersections.
5. Do not pass vehicle ahead on curves.
6. Do not pass vehicle ahead on grades or hills.
7. Do not follow vehicle ahead too close. State law prohibits trucks from traveling closer than 100 feet except when passing.
8. Stay in line when traffic is heavy.
9. Stay on right side of road when on way to and from work.
10. Do not stop on roadway.
11. Do not move against traffic unless nature of work makes it unavoidable.
12. Place torch or flare 100 feet in rear of truck if stalled at night.
13. Place red flag in upright position on shoulder of highway at least 200 feet in rear of truck when stop is made in daylight on roadway.
14. Inspect lights every two hours when on road at night. (Do not stop on highway to make inspection. Stop at next town.)
15. Before backing be sure no person or vehicle is behind truck. Back slowly. Have helper at rear if possible.
16. Apply brakes slowly. Do not make sudden stops.
17. When making left turn give oncoming traffic sufficient warning. Stop for safety.
18. Use extreme caution when children are on the road.

These rules were stressed at a series of employes' safety meetings held at the headquarters of each of the sixteen maintenance districts last month. Although employes' responsibility has been shown in very few of the accidents involving highway equipment, the department is conducting a continuous campaign to prevent such accidents. This is being done for the protection both of the public and the employes.

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Highway Mileage of Ecuador.—In 1930 Ecuador reported highway mileage as follows, according to *Foreign Highway News*:

	Miles
Unimproved earth roads	2,232
Improved roads (graded and drained)	1,578
Total	3,810

In addition there were 1,126 miles of trails. 179 miles of improved roads were constructed in 1930 and 18 miles the first five months of 1931. The roads in the low coastal region are passable only in the dry season, and some of the mountain roads are subject to slides. On Jan. 1, 1931, there were 2,492 motor vehicles registered in Ecuador, as follows: 1,422 passenger cars, 174 busses, 823 trucks and 73 motorcycles.

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Toll Roads Dwindle.—Hardly more than a score of toll roads still exist in the United States, all of them being privately owned. The total length is estimated at less than 150 miles, according to the Bureau of Public Roads, United States Department of Agriculture, as contrasted to the 3,000,000 miles of the public-road system. Thirty-five States have no toll roads of any kind.

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Highways in Greece—The total mileage of Greek highways, as of December, 1931, was 6,719, divided as follows: Earth, gravel and other bound macadam roads, 6,645; bituminous macadam roads, 31 miles; asphalt paved concrete roads, 43 miles. While no other official statistics are available as to the exact number of motor vehicles in operation in Greece, the trade estimates the number in operation on December 1, 1931, as follows: Passenger cars, 12,500; trucks, 5,200; and buses, 1,300; making a total of 19,000.

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In shoulder maintenance the trend seems to be toward rounding the shoulders so a mowing machine can be used in weed control.

Location Methods Zion-Mt. Carmel Highway

By Henry H. Blood
Chairman, Utah State Road Commission, Salt Lake City, Utah

PRELIMINARY to a description of the methods used in the engineering location work of this famous highway, perhaps it will be well to give some general information as a background. There was a very definite need existing for this highway which justified the expenditure of approximately $2,000,000 on a 24-mile length. One important need was a more satisfactory connection between Zion National Park, the north rim of the Grand Canyon National Park to the southeast, and Bryce National Park to the northeast. Compared with the then existing roads the Zion-Mt. Carmel highway would save 15 miles distance between Zion and Grand Canyon, and 65 miles distance between Zion and Bryce Canyon. This new route would also provide a very important necessary inter-county highway, and in addition form a valuable link connecting the important north-south highways, U. S. No. 89 and No. 91. In addition to these advantages, the new route offered unusual scenic attractions whereas the then existing road via Pipe Springs possessed very little of a scenic nature.

General Description of New Highway.—This new highway is located partly within the confines of Zion National Park and partly without. The 7.5 miles within the park represents the section where the cost was the greatest and the engineering features were the most unique. Credit for the engineering work on this section must go to the Bureau of Public Roads and the National Park Service and much of the information submitted in this report has been kindly furnished the writer by engineers of the Bureau of Public Roads.

The remainder and longer section of the road was executed as a standard Federal Aid Project by the Utah State Road Commission in cooperation with the Bureau of Public Roads. This state section furnished the usual problems encountered in mountain location and construction with no particularly unique features. The portion within the Park included the ascent from the floor of Zion Canyon proper to the plateau above and the traversing of the solid rock canyon of Pine Creek. The state section traversed a typical mountain plateau section and dropped down into a tributary of the Virgin river at Mt. Carmel Junction.

The fundamental problem of highway location which had to be met on the section within the Park was to make this ascent to the plateau above. The walls of Zion Canyon rise almost perpendicularly to a height of approximately 3,000 ft. above the valley floor. The canyon wall is cut on the south by the entrance of Pine Creek and early in the investigation it was seen that this tributary would have to be used to make the climb. The 7.5 miles might be divided for descriptive purposes, into three sections.

The lower section of approximately 3 miles consists of a fairly wide canyon bordered by vertical sandstone cliffs with steep talus slopes at the bottom of cliffs on both sides. The elevation of the top of the talus slopes is approximately 1,000 ft. above the floor of the main canyon at the point where it is joined by Pine Creek.

The second or middle section is within a winding box canyon barren of soil of any kind, the greater part of which was inaccessible on account of narrowness of the gorge and falls or perpendicular drops in the bed of the stream channel.

The third or upper section is located in a rather wide canyon of solid rock barren of soil over which the creek meanders in a very circuitous manner, the solid rock slopes, however, not being vertical but inclining on angles between 30° and 45°. This upper section could be handled by the ordinary methods of location inasmuch as the slopes are flat enough so that an ordinary transit line could be projected.

Surveying Methods.—The critical point in the entire survey was to negotiate the center section which was entirely inaccessible for ordinary location methods. As a preliminary step, a plane table survey was made of the lower section of Pine Creek, extending from the floor of the canyon to the top of the talus slopes. This located the border line forming the perpendicular cliffs arising above the talus slopes. A contour map was then prepared showing the cliff lines and intermediate elevations. It was always known that a tunnel would be necessary to carry the road through much of the middle section above, and the next step was to carry the survey lines over this territory. Before starting this line it was necessary to blast a trail along the side of the vertical cliff in order to negotiate a section where the stream dropped perpendicularly 100 ft. This trail was a little over 100 ft. long and on a 50 per cent grade, and by use of it was possible to get a transit line several hundred feet up in the center gorge from which point it was necessary to triangulate to the point on the top of the cliff summit which line could be carried on to the third section. In order to reach the triangulation points the survey party had to climb with ropes a vertical cliff 300 ft. high.

With the information thus obtained it was possible to establish the control elevation of the east portal of the long tunnel which in the end turned out to be 1.1 miles in length. Then, by adopting a 5 per cent grade, a tunnel line was projected which determined the point at which the tunnel line met the top of the talus slope at the base of the cliffs thus giving the control point for the lower portal of the tunnel. Having thus established the control elevations of the tunnel portals, the next step was to secure accurate topography of the face of the cliff, in order to be sure that there were no deep crevices where the tunnel would break through into the open.

This topography was taken with two transits at opposite ends of the base line, taking readings on the same point simultaneously. The use of two transits eliminated the possibility of error in identifying the points observed as it was impossible to reach them on account of their height above the base of the cliffs.

Having obtained the topography of the face of the cliff, it was then possible to make an accurate projection of the tunnel line and determine the point at which the side galleries would be located.

The unique feature of the location of this long tunnel was in the fact that where ordinarily it is possible to run a base line over the tunnel, in this case it was necessary to locate and lay out the tunnel from an irregular triangulation, or base line, at the side of the cliff and considerably below the tunnel grade. From this base line galleries were located at definite points and the construction contractor built platforms at tunnel grade elevation on the side of the cliff with stairways leading up to them from the top of the talus slope below. Drilling was then started from these platforms and the galleries were carried into the center line of the tunnel and from these points headings were made in both directions, the waste being dumped out at the gallery openings. Tunnel excavation was thus put under way at several points simultaneously.

After drilling was started at these various galleries a point on the outer edge of each gallery was established and its position and elevation measured by triangulation from the base line. Distance and bearing to a point on the tunnel center line was then computed and this point located by transit set up on the point previously established on the edge of the gallery. As soon as the gallery excavation reached the center line, the transit was then set up on the center line points and the direction of the center line established by turning angles previously computed. A pilot tunnel 8 ft. x 9 ft. was first put through and afterwards enlarged to the full tunnel section, 16 ft. high and 22 ft. wide. The greatest error in center line at points where tunnel heads met was 0.08 ft.

The lower section consisting of the climb from the main floor of Zion Canyon to the lower tunnel portal was made by a series of zig-zags, six in number. This location was projected in the ordinary way from the preliminary topography. The zig-zags are so numerous that at one point there are five roadways at different elevations, one directly above the other. The alignment of this section was provided with easy radius curves of proper standard.

Acknowledgement.—The foregoing was contained in the Report of the Committee on Highway Location, presented at the 1932 Convention of the American Road Builders Association.

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Laning of Traffic

The benefits to be derived from marking traffic lanes on street surfaces are so obvious as to require little argument to prove the case. No objections to the idea, worthy of mention, have thus far advanced.

The principal barrier to the more widespread use of street surface markings is the difficulty in securing an economical device or material adaptable to all surfaces that will be permanent and present good visibility under all conditions.

Streets are laned primarily to direct traffic into the desired or required channel of flow. In effect, laning is to the free wheeled vehicle what the rails are to the street car.

The results to be expected are:

1. The lessening of confusion.
2. Reduction of accidents.
3. Classification between slow moving, heavy duty vehicles and the lighter, faster moving passenger cars.
4. Orderly arrangement of vehicles at the approach to intersecting streets.
5. More expeditious movement of traffic.
6. Increased street capacity.

Lanes, arrows and sometimes a word or two marked on the pavement to direct traffic into proper position to make left or right turns or to rotate around a circle lessens confusion.

Such markings in a short time become familiar to regular drivers and are in the best possible place to give information to strangers.

When lanes are marked, it is a degree of assurance to each driver who keeps within his own proper lane, that he may proceed with reasonable security and not expect his right of way to be preempted by some other driver.

Both of the reasons stated have the tendency to reduce accidents.

Sometimes the lanes are marked with words to indicate that they are for "slow moving" or "heavy duty" vehicles. State laws require that slow moving vehicles keep in the extreme right lane. Police are sometimes active in requiring obedience to the regulation which results in classification of the traffic and the segregation of trucks and buses in one lane, leaving the other for faster vehicles.

Lanes marked at least within the last 50 or 75 ft. on the approach to an intersection have the effect of arranging vehicles in orderly manner when stopped at an intersection. If lanes are marked for turns, there is less conflict of turning vehicle with through vehicles.

Traffic movement may be expedited by this orderly arrangement. Three or more vehicles abreast can get away as one when the signal changes; but three in line require much more time to get into motion one after the other. In the case of segregating traffic, lane marking permits the fastest vehicle lane to proceed uninterrupted. If slow moving vehicles are all over the street, the entire traffic movement is reduced to the speed of the slowest.

There is an actual and measurable gain in street capacity attributable to lane marking. All of the foregoing factors "free up" the movement and enable the same street to carry from 35 to 50 per cent more traffic.

One difficulty encountered in the practical use of traffic lanes is the negligence of the occasional driver in "straddling" a line and if he is a slow driver, this "hog" usually has a long line of cars following him. Observance of lanes approximated 87 per cent on a short series of observations at several places on different days.

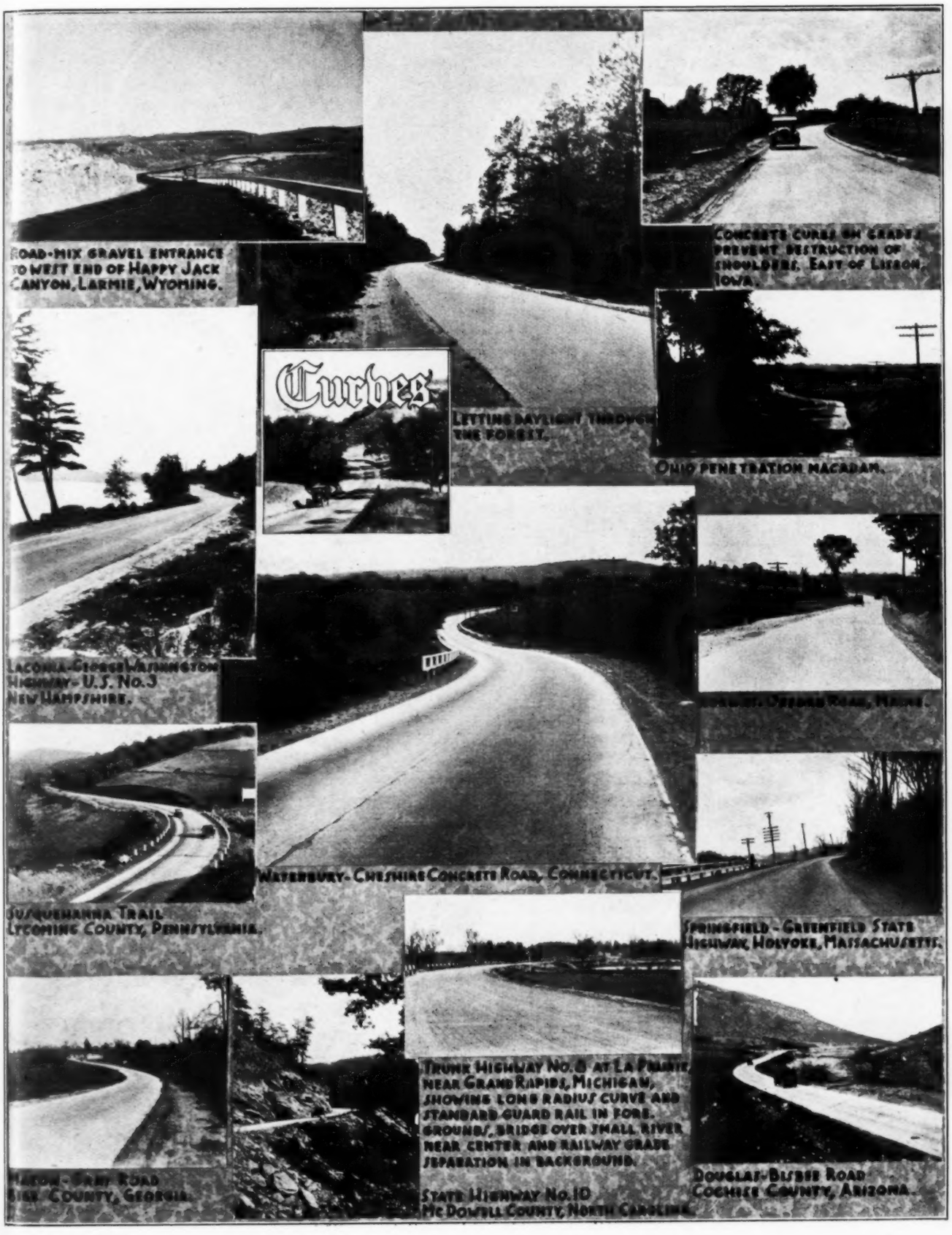
Another difficulty is in keeping traffic orders keenly awake to the importance of breaking up the practice of "straddling" or of the slow vehicle in getting out of its proper lane.

There should be sounded a warning against making lanes too narrow. At least the curb lane, or extreme outside lane for moving traffic should be of ample width to accommodate trucks and buses. Ten feet is not too much. There is always the tendency for the driver of the large vehicle to keep away from the curb or from a line of parked cars.

On the whole, lane marking is well worthwhile.

Acknowledgment.—The above is a section of the report of the Committee on Traffic, presented at the 1932 convention of the American Road Builders Association.

BANNER HIGHWAYS


Curbes
ROAD-MIX GRAVEL ENTRANCE TO WEST END OF HAPPY JACK CANYON, LARMIE, WYOMING.
CONCRETE CURBS ON GRADES PREVENT DESTRUCTION OF SHOULDERS. EAST OF LISBON, IOWA.
LETTING DAYLIGHT THROUGH THE FOREST.
OHIO PENETRATION MACADAM.
TACOMA-GEORGE-WASHINGTON HIGHWAY - U.S. No. 3 NEW HAMPSHIRE.
WATERBURY-CHESHIRE CONCRETE ROAD, CONNECTICUT.
SUSQUEHANNA TRAIL LYCOMING COUNTY, PENNSYLVANIA.
SPRINGFIELD - GREENFIELD STATE HIGHWAY, HOLYOKE, MASSACHUSETTS.
TRUNK HIGHWAY NO. 8 AT LA PRAIRIE NEAR GRAND RAPIDS, MICHIGAN, SHOWING LONG RADIUS CURVE AND STANDARD GUARD RAIL IN FORE-GROUND, BRIDGE OVER SMALL RIVER NEAR CENTER AND RAILWAY GRADE SEPARATION IN BACKGROUND.
DOUGLAS-BISBEE ROAD COCHISE COUNTY, ARIZONA.
STATE HIGHWAY NO. 10 MC DOWELL COUNTY, NORTH CAROLINA.

EDITORIALS

President Hoover's Unwise Objections to Increased Public Works Construction

PRESIDENT HOOVER, in a letter to the president of the American Society of Civil Engineers, expresses disapproval of increased federal appropriations for public works that are not "income-producing works." He thinks he sees a vital economic distinction between a waterworks that produces income and a road that produces no income. He thinks he sees an important distinction between a toll bridge and a bridge that is toll-free, because the one brings in revenue directly while the other brings it indirectly. If a highway bridge is of economic advantage to a given community, since when did the absence of a toll-gate render it uneconomic?

By the President's own logic, all we need do to gain his approval of larger federal appropriations for roads would be to make them toll-roads. Then—presto!—they would become good investments for public funds. Now the fact is that whether a good road is a good investment has no relation to its direct income producing capacity in the form of tolls, but only to the money that it saves in transportation as compared with a poor road.

It so happens that all of our roads are direct producers of income, because of the taxes on gasoline. Those taxes are the tolls paid for the use of the roads. But if not a dollar were collected in this manner, still our good roads would be economically desirable, and continued increase in the mileage of improved roads would be a wise act.

President Hoover fortunately gave a specific example of the distinction that he thinks he sees between an income producing plant and one that renders a free service. The Pennsylvania Railroad Company recently applied to the Reconstruction Finance Corporation for a loan of $55,000,000 to be used in electrifying certain parts of its lines where the total cost would be $68,000,000. The company was granted a loan of about half the amount requested. It is estimated that this $68,000,000 construction will keep 28,000 men busy for a year. By way of contrast, President Hoover cites the proposed federal appropriation of $132,000,000 as a "subsidy" to the states for highway improvement. He says: "By this action we would give employment to only 55,000 men at the expense by the government of $132,000,000 which will never be recovered."

He contrasts the employment of 28,000 men on the railway electrification project with the 55,000 on the highway project, and evidently regards the government's loan of $27,000,000 to the railway as being several fold more desirable than the proposed $132,000,000 investment in road improvement. Being an engineer, President Hoover feels the weakness of such a comparison, for he hastens to add that "the highways in many sections have been expanded beyond immediate public needs;" but he does not add that the same is true of the railways. Only once does he touch upon whether continued road improvement is desirable, and then becomes a special pleader for a false economic theory when he says that many localities have better roads than they need, without saying that most localities still have poorer roads than they should be compelled to put up with.

The entire road using public is a better judge of what they need than is any one road user, even if that one is the President. Their judgment of what they need is clearly shown in two ways, first by their purchase of one motor car to the family, and, second, by the continued use of those cars during this financial depression. We know of no utility whose use has decreased so little in these hard times as the highways. Indeed there has been scarcely any decrease in the sales of gasoline, whereas railway passenger and freight traffic has declined more than 20 per cent. In those facts you have the public's judgment, as compared with the President's judgment, as to which of these two kinds of highways calls most loudly for improvement.

However, the basic question here is not one of relative economic importance of roads and railways. It is this: Should the public continue to improve and expand the utilities that it owns? If the answer is yes, then when was there a better time to make such improvements? Water works, sewers, bridges, roads, streets, public buildings—all call for much greater expansion than normal when business is subnormal.

President Hoover, however, raises the objection that public works expansions greatly "unbalance the budget." But do they? Construction expansion based on bond issues has no effect upon budgets save as to annual interest and sinking fund requirements. The $1,200,000,000 of supernormal federal expenditures for public works during 3.5 years (including next year) does not represent a sum that must be raised out of current taxes. Only the annual interest on that sum need be charged to current budgets, and then it dwindles to a very small gesture on the part of the federal government, for it is barely $50,000,000 a year.

President Hoover argues against diverting capital from private enterprises by increasing public expenditures. But one of the great troubles at present is that almost no capital is flowing into private enterprise. There can be no diversion of a non-existing current. It is the belief of those who advocate large bond issues for public improvements that the expenditure of the capital thus raised will serve to give employment and thus aid in opening the credit valves through which a steadily increasing stream of capital will flow. . Perhaps this belief is an illusion. If so, prove it from past experiences, or cease objecting to an experiment that holds such great promise of success.

President Hoover, in the letter that we are criticising, says:

"I have for many years advocated the speeding up of public works in times of depression as an aid to business and unemployment. That has been done upon a huge scale and is proceeding at as great pace as fiscal stability will warrant." Then to prove the contention he cites the fact that from Jan. 30, 1930, to June 30, 1932, the federal government will have expended $1,500,000,000 on public works, and up to June 30, 1933, the total will be $2,075,000,000. This, he adds, will be $1,200,000,000 above normal for these 3.5 years. This simmers down to a supernormal expenditure of only $343,000,000 a year by the federal government. This is the President's idea of adequate expansion of federal public works during a depression. But it is hard to reconcile it with his avowed belief in public works expansion as a means of alleviating distress during the depression. He says, but fails to prove, that states and cities "have greatly expanded their public works." The facts that we have gathered show the exact contrary. While the shrinkage in state and municipal expenditures for public works will be slight in 1932, it will be enough to demonstrate that they have not followed the better example set

by the federal government. The latter has done so little as to be negligible in its effect even as an example. The President has a commendable fondness for statistics, hence his failure to give any figures relative to state and municipal expenditures for public works may be safely taken to indicate that he had none that would show a noteworthy attempt to expand public works during the past 2.5 years. Perhaps the states and cities have done well in almost "holding their own." But certainly it is a mistake to cite their activities as evidence of a serious attempt to stem the tide of depression by increasing public works construction. The federal government made a gesture. The states and cities, taken as a whole, ignored it. And now President Hoover tells us that the municipalities and states "have reached a stage where they have anticipated the need for many such works for a long time to come." This is the most astonishing statement in President Hoover's very astonishing letter.

We suggest that the American Society of Civil Engineers should gather and present for public review a comprehensive array of facts as to public works construction throughout America during the past 2.5 years. Otherwise the President's misleading inferences from inadequate data will be quoted far and wide, and may lead to as great a shrinkage in public works construction as now exists in private enterprises.

W. P. Gillette

Open the Throttle

CONGRESS, and the president, still continue to hold the check on highway improvement programs. Present conditions in the highway industry clearly indicate that federal aid for highway work is truly a "throttle" for the industry. As long as the throttle is held closed just so long will highway work have to operate on stored up energy. The situation is similar to a steam engine that has been running smoothly under the guiding control of the engineman.

At the present time the engineman has fallen asleep and shut off the throttle. The inertia of the flywheel keeps the engine running just as the built-up energy of previous road and street programs keeps the road and street movement going. But like the engine it is running with a marked deceleration and will shortly stop unless the throttle is opened.

Therefore the present duty of everyone connected with road and street industry is to wake up the engineman. He is peacefully sleeping under the rigid guardianship of the president's fetish, the balanced budget.

From the time of the American Revolution up to the late war the governmental budget was in a fair balance except for the public debt. Balancing the budget refers to ordinary receipts and expenditures. Good policy dictates the gradual reduction of the public debt also. In the past eleven years the public debt has been reduced about one-third. This is perhaps a heavy reduction, but since it occurred during a period of national prosperity the action was not a hardship on this generation. If the 1933 fiscal year budget contains an expenditure for public debt reduction similar to that of the past few years it should be eliminated and only the interest included.

Congress would do well to quit its political bickering at the expense of the American people and work for us as they were elected to do. In presenting the balanced budget they could and should include an expenditure for public works, the amount of which would represent simply a first annual cost on an investment in those public works. Highways are an investment in plant, *not an annual operating expenditure.* Furthermore, highways are paying investments. If tolls were charged in amounts equal to what vehicle operators save because of operation over surfaced roads as against operation over unsurfaced roads the income would be sufficient to construct more roads annually than have been constructed in any single previous year. For this reason, and to the exclusion of all others, a sum should be included in the expenditures side of our national budget equal to, or greater than, any previous federal highway appropriation. To further guard our sleeping enginemen the president is taking the stand that any and all public works programs should be "self-liquidating." He has attacked "non-productive" public works construction. What does he mean by "self-liquidating" and "non-productive"?

We must shout loud enough to awaken the engineman —with letters to our senators and representatives. We must support movements destined to promote road and street work. We must continually pull at the "throttle" until we get it open.

Army Highway Supervision

WHILE we believe in the army as an instrument of national defense and an asset of our federal government we think that to place them in charge of federal highway work is a serious handicap to future highway development. The profession of arms and the profession of engineering are separate and distinct. To be efficient as a soldier the army officer must necessarily study international political trends, national economic conditions of other countries, war plans, defense plans, foreign governmental organizations, armament, materiel, and supplies. Soldiering is not highway engineering.

The fundamental training of army officers at West Point is, as it should be, broad and liberal with specialization in military matters.

Highway engineering is a specialized practical science. To be efficient in it one must be grounded in the application of science to highway construction, administration, maintenance, traffic and highway development. Army officers do not and should not receive the specialized education necessary for them to function efficiently as highway engineers. Preparation for efficiency in war, or combat efficiency and troop leadership is one thing, highway engineering is another entirely different thing.

H. R. 11597 while containing the thought of public works consolidation under one head, as desired by the present administration, employs the wrong means for accomplishing this purpose and should be defeated. The next logical step in government, if this bill should become a law, would be a dictatorship in the United States.

We wholeheartedly oppose this bill.

No-Road-Work Policies

ROADS break up rapidly when not kept in repair. Reducing maintenance to reduce taxes is false economy. Yet this thing is occurring amongst the counties. Some counties are releasing their engineers and have announced that they will do no road work next year. Parsimony!

The county that embarks this year on a no-road-work policy had best protect their interests with big signs on their highways thus: "Cutting Taxes; No Road Funds; Travel At Your Own Risk!"

V. J. Brown

BEFORE

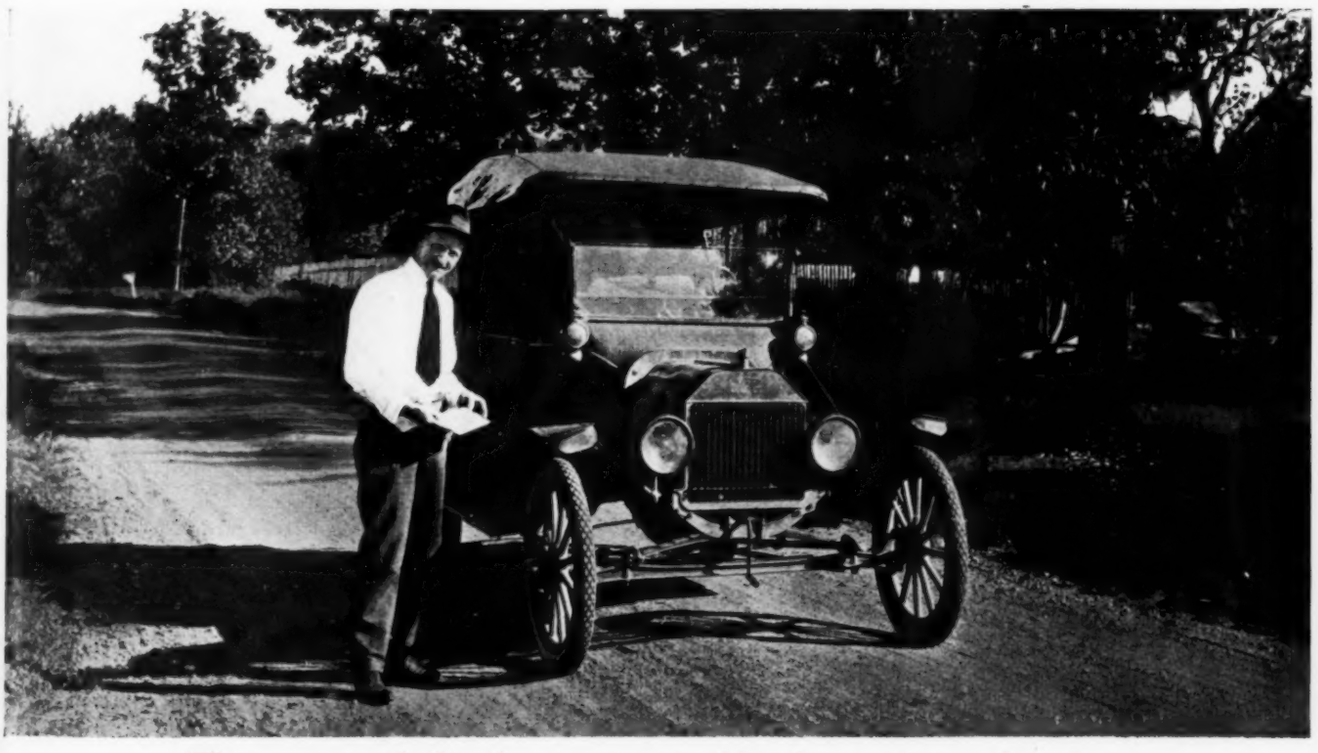
In the old days the children walked over muddy roads to nearby rural schools. The single room "little red schoolhouse" predominated.

This mudhole on one of the Arkansas rural roads made drudgery of automobile driving.

Pictures on these two pages courtesy

AFTER

Now the school bus transports the scholars over comparatively long distances to modern consolidated schools. "The little red school" is slowly disappearing.



The same road after improvement with a low-cost gravel surface lightened the cares of rural automobile owners.

of the U. S. Bureau of Public Roads

County and Township Roads

PLANT-MIX

Loading Pre Cote from Machine Into Truck, Emulsion Supply Tank Shown

Coarse Aggregate Type Road Built With Portable Units

Pictures show continuously, step-by-step, operations in the building of this Wisconsin road. Tar was blended with the asphalt in making up the emulsion

Water Softener, Emulsifier, and Insulated Bitumen Tanks

APPROXIMATELY 12 mi. of 20 ft. surfacing on U. S. Highway No. 8 near St. Croix Falls, Wisconsin, were laid late last fall using an aggregate for binder of a size from 2 in. to 5/8 in. This coarse graded type surfacing was laid over a traffic-bound, gravel and stone road which would average about 3 in. of consolidated metal. Of outstanding interest on this job was the equipment used in producing the bituminous resurfacing mixture.

One unit was a portable emulsifier which emulsified the bitumens at the site of the work and permitted varying the grades of emulsion to fit requirements. The other unit was a type of plant for combining the emulsion with the aggregate, which was unique in operation. It accomplished the precoating of the aggregate by immersion in a vat of emulsion through which a conveyor equipped with perforated buckets continuously picked up the coated aggregate and allowed the excess bitumen to drain off.

The plant was set-up at a quarry so that stone could be handled by crane through a bin into the coating machine. Work was begun on September 28th and by November 15th approximately fourteen thousand tons of coated material had been manufactured and laid. This was a very late period to be working in northern Wisconsin, as the average frost date is September 15.

The pavement was laid between 3 in. by 3 in. wood forms of which the contractor had two miles available during the work. The binder course was approximately two inches in depth with about one inch thickness of wearing course. The entire 12.1 mi. of 20 ft. pavement was completed and put in service by the first of December. The usual daily output of pavement made and laid was in excess of five hundred tons. The Wisconsin State Highway Commission supervised all stages of the work.

Approximately the first 2 miles of the contract were laid using an aggregate for binder of a size from 2 in. to 5/8 in. The asphalt used was a paving material having a penetration averaging about 110. The wearing course was made up of the same asphalt and chips designated as 5/8 in. chips. On these first 2 miles of work, a standard asphalt emulsion was used on the binder size; the emulsion contained 65 per cent of bitumen; the water had been passed through a water softener and treated with 2½ lb. to each 500 gal. of a chemical which insured that the water would be soft. Sufficient caustic was added to saponify the fatty acid introduced into the asphalt. One per cent of fatty

Old road surface before and after shaping, cleaning, and spreading prime coat. Superimposed picture shows spreading of binder course

acid based on the asphalt content was present in the emulsion. The temperatures were so designed as to deliver the emulsion below the boiling point of water and the average temperature of the emulsion, before entering the Pre Cote vat, was 180 deg. F.

For coating the chips used in the wearing surface the asphalt and the water were treated in the same manner, but the bitumen only averaged 55 per cent. The aggregate used was a hard, slick material bearing a light film of dust and usually wet or damp. The standard asphalt emulsion did not adhere well to the binder size aggregate and it was necessary to make an application of emulsion after the binder stone had been placed and rolled, in order to insure that spots which had peeled would be again coated with bitumen. The chips did not show as much peeling as the binder size aggregate, because they bore a greater percentage of bitumen.

A seal coat of approximately 0.65 gal. per sq. yd. of 50 per cent asphalt emulsion was placed over the surface in two applications. These applications were covered with limestone grits in a total amount of approximately 8 lb. per sq. yd.

At the end of the two miles described above, a different emulsion was manufactured to insure uniform coating and workability of the particles of aggregate. The asphalt described above was used and a tar having a viscosity of approximately 60 to 80 was introduced into the emulsion to increase the adhesive qualities of the bitumen film. The water was treated as in the standard emulsion but 1¼ per cent of fatty acid was used based on the tar and asphalt content of the emulsion.

For the binder size aggregate, an emulsion was used bearing 58 per cent asphalt, 10 per cent of tar, or a total of 68 per cent of bitumen. On the wearing course or chips, these percentages were changed to 50 per cent of asphalt, 7 per cent of tar, or 57 per cent of bitumen in the emulsion. After the tar-asphalt emulsion was manufactured it was not necessary to seal the binder course. The bitumen film adhered to the particles of aggregate satisfactorily and the workability of the material on the road was increased. The seal coat material used on both the asphalt emulsion and the tar emulsion, was of the standard asphalt type using 50 per cent of asphalt. The percentages of bitumen contained in the binder size aggregate were from 2 per cent to 3 per cent. The percentages of bitumen contained in the wearing course were from 4½ per cent to 5½ per cent.

In the above summation of quantities, averages have been used and in many cases the percentages of asphalt or bitumen were increased or decreased in order to maintain a uniform percentage of bitumen on the aggregate. In the Pre Cote process the percentage of bitumen contained on the aggregate is governed entirely by the surface area of aggregate. Naturally a stone passing a 2 in. circular opening and retained on a ⅝ in. circular opening would have much smaller surface area than the same volume of stone passing a ⅝ in. circular opening and retained on a No. 10 sieve. This is borne out by the fact that binder size stone would bear only 2 per cent to 3 per cent of bitumen, while the wearing course would bear from 4½ per cent to 5½ per cent of bitumen. By this process there is little danger of obtaining fat or lean spots in the pavement, as each particle of aggregate bears sufficient bitumen to coat its surface and an increase or decrease in the fines present in the aggregate did not change this condition, although it did increase or decrease the per cent of bitumen. In other words, spots could be present in the binder course where the aggregate would all be approximately ⅝ in. in size without making a hard, fat spot in the pavement. Emulsions must be designed to stand

Binder course spread and rolled—rolling wearing course—removing side forms

Rolling up earth berm after side forms are removed—applying hot emulsion seal with distributor—finished road

working and blading on the road because it is not practical to do work of this kind without having approximately ½ mi. of aggregate spread upon the road before the blading operation starts.

Items of considerable interest to those who observed the progress of this work were:

That the equipment is portable, mounted on wheels. The emulsifier weighs 3,000 lb. and the Pre Cote machine 15,000 lb. Three men operate the equipment.

The emulsion used for prime and seal coats, as well as that for coating the aggregate, was supplied at 180 deg. F. direct from the emulsifier and used at this temperature.

The coating film can be instantly varied by the operator to compensate for the condition of the aggregate.

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Letter to the Editor

In reply to the New England Road Builders' Association's opposition to Federal Aid participation in Day Labor highway projects as printed in the May issue of ROADS AND STREETS.

Federal Aid should be extended to include Day Labor projects because:

(A) 1. The number of men employed would be greatly increased.

2. Small local enterprises will receive more benefits in proportion from Day Labor projects than they now receive from Contract projects.

3. The source of Federal Aid funds is taxation, since all of the people are taxed it is no more than fair that as many of our citizens be employed on Day Labor projects financed by Federal Aid funds as possible.

4. Under the present system of awarding highway projects, it is impossible for small local contractors to compete with the large contractor financed by organized capital. The large contractor usually sub-lets his contract to small local contractors at a lower figure than is called for in the original contract. Is there any particular reason why the state should pay organized capital a royalty on its road work?

5. Due to the nature of Day Labor projects, it will be necessary for the state's men to take the places of the contractor's superintendents and foremen. These men can be required to meet the same or better qualifications that are met by the contractor's men. There is no reason why the efficiency of Day Labor projects cannot equal or exceed the efficiency of Contract projects.

6. At the present time it is not hard to obtain high class men for any position.

(B) 1. No organization is over-manned as long as each individual employed by that organization is kept constructively busy. The same principles of organization can be made to govern Day Labor projects as at the present time govern Contract projects.

2. Power machinery should be used on Day Labor projects the same as on Contract projects, but the machinery should be owned by the State. The State should be able to get a big discount on the purchase price of this machinery through buying in quantities and taking advantage of its discount rates. The contractors will try and tell the public that the money so spent by the State for machinery could be used to secure more highway mileage. This is not the case, for the contractor must purchase this machinery for a contract job and must pay for it out of the profits of his contract. The State eventually pays for all of the machinery used in the construction of its highways, so why not have the State purchase the machinery in the first place?

3. The Federal Government holds the State Government responsible for the satisfactory completion of a Federal Aid highway project. The project must comply with the specifications set down in the project agreement as to the quality of the materials used on such project and the workmanship and final finish of the completed job. The Federal Government makes no exception for a Day Labor project.

4. There is a tendency on the part of contractors to "Out Smart" the State's representatives whenever the chance to do so occurs. It is true that there are a few honest contractors, but the general run of contractors make it necessary for the State's engineer to get "Hard Boiled" in order that the contract be properly executed. There is a tendency for contractors of this type to avoid government contracts as they know before hand that the Federal Government will insist on the terms of the contract being exacted to the last letter.

5. The efficiency of the State's engineers and inspectors has been greatly increased during the past decade due to the high standards that have been set for Federal Aid projects and to the constant vigil of Federal engineers. It will not cost the State any more to keep an "Eagle Eye" on a Day Labor project that it now does on a Contract project.

6. Men employed on a Day Labor project may be held at one level, promoted or fired, depending on the merits of the individual. Each man should be given a routine job. He will then become efficient in carrying out the duties of his job and the result will be finished products of uniform quality. It is interesting to note that the finished product of two different contractors varies greatly as to quality due to the difference in the type of the two organizations.

(C) 1. The statements outlined in the New England Road Builders' Association's article should not be accepted by the public as facts, as each of the statements made are questionable.

2. The major issue at the present time seems to be: Shall Federal Aid funds be absorbed by Organized Capital or Unemployed Labor? The decision should go to the Unemployed Labor because all earnings will be put back in circulation, whereas Organized Capital retains a large per cent of their profits although their records may show that they operated at a loss when it comes time to make out the yearly income tax report.

(D) 1. Day Labor projects have been carried out in experimental form by various states during the past year. The results while not perfect, have been very satisfying. These experiments have proven decisively that the unemployment situation was noticeably relieved during the activity of the Day Labor projects.

2. It would seem therefor that the majority of the people have everything to gain and nothing to lose if the Federal Government would extend Federal Aid to Day Labor construction during the remainder of the present crisis.

F. G. Orcutt,
Civil Engineer, 1825 South Emerson St., Denver, Colorado.

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ALUMINUM TRUCK BODIES—For the U. S. Bureau of Mines fuel yard in Washington, six automobile dumping trucks were built in 1931 to haul coal, with bodies wholly of aluminum, excepting the hoisting mechanism. These bodies are 11 ft. long, 7 ft. wide and 3 ft. 9 inches high inside; they weigh 1,420 lbs. each. Each truck travels 50 to 60 miles a day.

The Development of Feeder Roads in Maine

By LUCIUS D. BARROWS

Chief Engineer, Maine State Highway Commission

MAINE has an area of 33,000 square miles, approximately 23,000 miles of highway, a valuation of $757,000,000, and a population of about 800,000.

Classes of Highways.—With this general background the legislature has divided the roads of the state into three classes: First, state highways, which mean a system of connected main highways throughout the state; second, state aid highways, which mean such highways, not included in the system of state highways, as shall be thoroughfares between principal settlements, or between settlements and their market or shipping point, and in so far as practicable feeders to state highways; and third, third class highways, which mean all other highways not included in the first two classes. This classification was made in 1913. Later, in 1919, the legislature provided that from the general classification of third class highways, one third class highway might be designated in each town by the municipal officers, with the approval of the State Highway Commission, for improvement with apportionments from a state fund which was made available for the purpose.

As the federal aid system is included in the state highway system, the state is carrying on the development of three separate systems of highways. The state highway system includes 2,317 miles; the state aid highway system 4,666 miles; and the third class system on which state funds are expended 1,823 miles.

Cooperation with Towns.—In the construction of state aid and third class roads the state highway department works in cooperation with about 540 towns. Practically every town and city in the state each year appropriates funds for state aid road construction. While the methods of financing the construction of state aid roads and third class roads are different, all work on both systems is under the direction of the state highway commission and the methods and requirements of construction are substantially the same. We feel that both systems may be included in the general classification of feeder roads.

Considering the resources of the state, we believe the construction of feeder roads has had a rapid growth. The general scheme of cooperation with the towns has been followed ever since the state first made an appropriation for road improvement in 1901. The first law providing for the participation of the state in road improvement was passed by the 70th legislature in 1901 and the sum of $15,000 was appropriated for the purpose of carrying out the provisions of the act. Under this law, in order for towns to receive aid from the state it was necessary for the towns to expend at least $100, and provision was made for the state to reimburse towns to the extent of one-half the expenditure, the reimbursement not to exceed $100. These first state aid roads were designated by the county commissioners, who looked after the work. This work was not placed under the direction of the state highway department until 1908. It is interesting to note that in 1901 twelve towns took advantage of the act and constructed 2.56 miles of highway at a total cost of $3,025. Against this cost the state aid paid to the towns amounted to $1,175.

Beginning of State Highway Commission.—The state highway commission was organized in 1913. In this year the state appropriated $250,000 for state aid road construction. The total expenditure was $403,003, of which the state paid $195,806. The mileage constructed was 108.67. In 1930, 346.65 miles of state aid road were completed at a cost of $3,913,839. The sum of $626,818 was expended on uncompleted work and for reconstruction, making the total expenditure $4,540,658, of which the state paid $3,069,867. In addition to state aid road construction 101.93 miles of third class road were completed in 1930 at a cost of $827,469, and the sum of $55,041 was paid on uncompleted and incidental work, making the total expenditure on this class of roads $881,510. The total expenditure on feeder roads, therefore, in 1930 was $5,422,169, against $403,003 in 1913. The towns' share of this expenditure in 1930 was $1,547,702, against $207,196 in 1913, and the state's share was $3,874,467 in 1930 against $195,806 in 1913.

Towns appropriated more in 1931 for state aid road construction than in any previous year. The expenditure has been somewhat less due to the fact that the appropriation by the state was limited to $2,700,000 by the legislature in 1931. The appropriation for third class roads is limited to $700,000.

As a net result of construction and reconstruction of state aid highways, we have 2,942 miles on the state aid road system as of Jan. 1, 1931, and about 678 miles of state aid road built on the state highway system. On the third class system 937 miles had been constructed to Jan. 1, 1931. Work on state aid and third class roads has included gravel, bituminous macadam, concrete and granite block, but fully ninety-seven per cent of the mileage has been of gravel construction.

How Commission Works with Towns.—We have said that this work is done on a cooperative basis with the towns; the method of handling the work must, therefore, include the towns. In regard to the location of work: Between July 15 and Aug. 15 of each year municipal officers are required by law to submit to the state highway commission recommendations for the location of the state aid road projects for the next year. The commission has authority to approve or change these recommendations and makes a report of its action to the towns, which is submitted to the people at the annual town meetings which, in Maine, are held in March. Towns notify the commission of the amounts appropriated and corresponding apportionments of state aid are set up, making a joint fund available for the work. As work progresses reimbursements are made to the towns in much the same manner as federal aid payments are made to the states, or, if town prefers, its appropriation may be deposited with the state treasurer and the commission handles all payrolls and payments. Work on third class roads is usually continuous from year to year but locations may be changed with the approval of the commission.

Town Appropriations for State Aid.—Three plans are provided in our law for the appropriation of funds by towns for state aid road construction. These are the one unit plan—the five unit plan—and the three town plan. What we have termed one unit is the base amount which any one town may appropriate for this work, depending on the valuation of the town. The apportionment of state aid against this unit also depends on the town's valuation. Following is a schedule of valuation classes

with corresponding one unit amounts by the town and the state:

Valuation of Town (State Assessors)	One Unit Appropriations	Rate of State Aid Per Dollar of Town Funds	State Apportionment
Up to $ 200,000	$ 300.00	$3.50	$1,050.00
$ 200,000 to 800,000	533.00	2.00	1,066.00
800,000 to 1,000,000	600.00	1.75	1,050.00
1,000,000 to 1,200,000	666.00	1.22	812.52
1,200,000 to 1,400,000	732.00	1.13	827.16
1,400,000 to 1,600,000	798.00	1.07	853.86
1,600,000 to 1,800,000	864.00	1.00	864.00
1,800,000 to 2,000,000	930.00	1.00	930.00
2,000,000 to 2,200,000	996.00	1.00	996.00
2,200,000 to 2,400,000	1,062.00	1.00	1,062.00
2,400,000 to 2,600,000	1,128.00	1.00	1,128.00
2,600,000 to 2,800,000	1,194.00	1.00	1,194.00
2,800,000 to 3,000,000	1,260.00	1.00	1,260.00
3,000,000 to 4,000,000	1,333.00	1.00	1,333.00

Towns having a valuation of over $4,000,000 may appropriate in addition to $1,333 a sum not to exceed $133 for each additional one million dollars of additional valuation, and the state will apportion a like increase.

Three-Town and Five-Unit Plans.—Using the one unit schedule as a basis the other two plans were later developed and were designed to encourage towns to make special efforts to do more work. Under the five-unit plan any town in any year may increase its appropriation up to a maximum of five units, in which case there is a like increase in the apportionment of state aid plus a bonus of twenty-five per cent of the increase. Under the three-town plan three or more adjoining towns through which extends a continuous road at least 15 miles in length may cooperate in its improvement and each town of such a combination may appropriate even multiples of the one unit amount up to a maximum of five units. A like increase is made in the apportionment of state aid plus a bonus which varies from 25 to 100 per cent, according to the number of units appropriated.

The 3-town plan and the 5-unit plan have given a great impetus to the construction of secondary roads. Out of 542 towns which made appropriations for this work in 1930 207 took advantage of the 5-unit plan and 192 towns appropriated under the 3-town plan.

In order to receive apportionments from the third class highway funds, towns must appropriate for town roads and bridge work an amount which makes a tax rate of at least $0.004. The state fund for this work is apportioned to towns in the ratio which the mileage of third class roads in each town bears to the total third class mileage of the towns eligible for aid.

Work on Day Labor Basis.—Practically all state aid and third class roads are constructed on a day labor basis. The work of laying out the roads, inspection and contact with municipal officers is handled through a corps of district supervisors. Until quite recently very little instrument work was done except on pavement work. Supervisors used their eyes for both transit and level and many of them became very expert in the use of this instrument. Within the last two or three years engineers have been assigned to work with supervisors and much more attention has been given to improvement in alignment and grades. Complete plans are not usually made except where changes of location are made involving new right of way.

In carrying on this day labor work it is believed that results obtained depend in great measure on the ability of the foreman. Local foremen are employed when they are competent. When outside foremen are assigned to the work they are instructed to build up the crews from local labor.

Very few of the towns have mechanical equipment. In order to have such equipment available for this class of work the state has purchased about 80 small power shovels and several units of compressor drills mounted on trucks. This equipment is placed on the work on a rental basis.

Secondary Road Construction.—In the construction of secondary or feeder roads we are concerned principally with gravel construction. For this work we have standard specifications which are printed and furnished to town officials, foremen and supervisors. Two typical sections are used for gravel roads, one providing for what we term a stone base with a 4-in. gravel surface, the other for a gravel base with a 4-in. surface. The width of road from outside to outside of shoulder varies from 21 to 27 ft. and the foundation or base courses from 16 to 20 ft., according to the importance of the road.

Stone base has been used to quite an extent on account of the supply of field stone suitable for use without excessive breaking. When stone base is used a sub-base of gravel not less than 2 in. in depth is spread over the sub-grade. Stone base is usually placed to a depth of 8 in. Stones must not exceed the depth of the course in their greatest dimension and are placed roughly by hand, the larger chinked with the smaller and voids are filled with gravel or coarse sand.

When gravel base is used it is placed to a depth of from 8 to 12 in. or more, according to conditions. Coarse well-graded gravel is used when available, including stone up to 4 or 5 in. Two courses are usually required and the material is spread so that no pockets of stone or binding material occur.

Before the surface course is spread the base must be filled and brought to proper cross section. In general, rollers are not available and very often surfacing is delayed in order to allow traffic to compact the base. In some cases surfacing is done in the year following the construction of the base course.

The surface course is the same whether stone base or gravel base is used. The material includes stone from 1¼ in. to 2 in., well graded, with sufficient binding material and fines to bond the course. When necessary binding material is mixed with the gravel. The material is usually spread in two courses, the top 2 in. being screened to 1¼ in. material. In the absence of a roller the gravel surface is machined and dragged while being compacted by traffic.

Other items of construction, such as guard rail and culverts, are substantially the same as used on state highway projects.

In 1930 the average cost of 332 miles of state aid gravel road was $8,758 per mile. In the same year the average cost of 101 miles of third class highway, gravel construction, was $8,021 per mile.

One of our greatest problems is the maintenance of these secondary roads. Towns pay a maximum of $30.00 per mile for maintenance of state aid roads and the balance must be taken care of by the state. Third class roads are maintained by the towns. Many continuous sections of state aid roads through adjoining towns have been completed and as a result traffic on these roads has increased. Bituminous surface treatment of gravel roads has given good results and a law was recently passed which allows the commission to use construction funds for this type of treatment in addition to maintenance funds. Bituminous surface treatment is being extended to state aid roads as far as funds will permit.

Acknowledgment—The foregoing is a paper presented at the 1932 meeting of the Association of State Highway officials of the North Atlantic States.

COUNTY OFFICIALS DECIDE *To Continue Progressive* COUNTY STUDIES

Twenty-one County Associations Now Affiliated With the County Highway Officials Division

THE annual meeting of the outgoing Board of Directors of the County Highway Officials' Division, of the American Road Builders' Association, was called to order in the association rooms at Washington, D. C., at 10 a. m., April 29, by Howard B. Keasbey, Vice President of the Northeastern District, who served as chairman, in the absence of the division president, Otto S. Hess.

An outline of the county attendance at the 1932 convention in Detroit classified as to states represented was read, showing a slight increase in county attendance over that in St. Louis with delegates assembled from 29 states.

The various reports presented at the convention were discussed and notice taken of the favorable recognition accorded them particularly the reports on "The County Planning Manual," "Aerial Photographic Maps" and "Uniform Accounting."

Affiliation of 12 Associations of County Officials Approved.—Be it Resolved by the Board of Directors in session, April 29, 1932, that the state associations hereinafter named have submitted application for affiliation are hereby enrolled as "affiliated" associations of the County Highway Officials' Division of the American Road Builders' Association.

County Commissioners' Association of Colorado—Fred O. Pearce, Secretary-Treasurer, Adams County, Brighton, Colo.

County Engineers' Association of Iowa—J. C. McLean, President, Sioux City, Iowa.

County Engineers' Association of Kansas—R. D. Coleman, Secretary, Atchison, Kansas.

County Commissioners' Association of Massachusetts—Frederick A. Leavitt, Secretary, Brookline, Mass.

Association of Road Commissioners and Engrs. of Michigan—K. I. Sawyer, Secretary-Treasurer, Ishpeming, Michigan.

County Commissioners' Association of Montana—E. J. Byrne, Secretary, Shelby, Mont.

County Engineers' Association of New Jersey—Harry C. Shinn, Secretary, Lakewood, N. J.

County Superintendents' Association of New York—L. P. M. Gaylord, Secretary, Lowville, N. Y.

County Judges' and Commissioners' Association of Texas—Ben F. Brooks, Secretary, Kauffman, Texas.

County Engineers' Association of Washington—Ross D. Alverson, Secretary-Treasurer, Everett, Washington.

Allied Counties of Nevada—T. S. Shuttleworth, Executive Secretary, Ely, Nev.

County Engineers' Association of California—Lloyd Bowman, Secretary, Santa Cruz, Calif.

Immediately after adjournment the annual meeting of the County Highway Officials' Division was called to order by Howard B. Keasbey, Vice President of the Northeastern District, who served as chairman in the absence of the Division's President, Otto S. Hess, Mr. Hess being detained in Michigan because of highway legislation pending before the special session of the Michigan state legslature.

The salient portions of the general association secretary's report were reviewed by Major Charles A. Browne, member of the executive committee. Special attention was given to the proposed Construction Congress, the Sustaining Membership Plan, Individual Membership Plan, and the status of the Emergency Highway Construction Bill. In order to further the individual membership drive it was recommended that each member of the Board of Directors be supplied with a list of members in his state and requested to use his personal influence to increase association membership among other officials eligible for enrollment.

Announcement was made of the affiliation to date of 21 state associations of county officials as compared with nine a year ago.

New Officers and Directors Installed.—Officers and directors elected at the business meeting in January were installed as follows:

President—W. O. Washington, County Engineer, Cameron County, Brownsville, Texas.

Vice President Northeastern District—H. E. Keasbey, County Engineer, Salem County, Salem, N. J.

Vice President Central District—H. G. Sours, County Engineer, Summit County, Akron, Ohio.

Vice President Western District—George W. Jones, County Supt. of Highways, Los Angeles County, Los Angeles, Calif.

Directors for Three Years—Term Ending 1935:

J. T. Bullen, Paris Engineer, Caddo Parish, Shreveport, La.

J. A. Bromley, County Roads Engineer, Anne Arundel County, Annapolis, Md.

Bent T. Collier, County Engineer, Coahoma County, Clarksdale, Miss.

Chas. W. Deterding, County Engineer, Sacramento County, Sacramento, Calif.

Don Heaton, County Surveyor, Benton County, Fowler, Ind.

Roy Jablonsky, County Surveyor, St. Louis County, Clayton, Mo.

George C. Wright, County Supt. of Highways, Monroe County, Rochester, N. Y.

In a brief address President Washington expressed his appreciation of the honor accorded him in his selection by the division as its president and pledged his best efforts for continued highway progress by counties. He requested all present to take an active part in the campaign for membership extension, stressing the value of a large and representative membership to strengthen the association in its efforts for stabilization of highway programs.

Committee Activities Referred to Board of Directors.—After committee activities for the coming year had been discussed at some length, motion was made, sec-

onded and carried that the five major committees of last year be continued with decisions as to specific subjects, committee chairmen and committee memberships to be made by the officers and board of directors. The major committees are:

1. Legislation, Administration and Finance.
2. Regional Surveys and Plans.
3. Design and Construction.
4. Maintenance.
5. Public Relations.

The meeting adjourned at 12:30 p. m. o'clock.

At 1:30 p. m. President W. O. Washington called the meeting of the Incoming Board of Directors to order.

Mr. Washington announced Executive Committee appointments as follows:

Hal G. Sours, County Engineer, Summit County, Akron, Ohio.

Howard B. Keasbey, County Engineer and County Solicitor, Salem County, Salem, N. J.

J. W. Mavity, County Engineer, Harvey County, Newton, Kansas.

Note.—The division president and treasurer are members ex-officio.

It was moved, seconded and carried that appropriate amendments to the county division constitution and by-laws be prepared so that they may generally conform with those of the general association, such being in order because of recent changes in the general association's constitution and by-laws.

Vacancy on Board Filled.—John J. McHugh, Secretary, Association of Chosen Freeholders of New Jersey, was nominated and elected a member of the Board of Directors to fill the vacancy for the unexpired term ending 1933 in place of B. W. Davis, Nashville, North Carolina; resigned because of transfer from county to state work.

Committee Activities.—Committee activities to be undertaken by the five major committees were discussed in greater detail than at the annual meeting. Suggestions of the retiring president, Otto S. Hess were presented as submitted by him in a special communication. As a result of general discussions, committee subjects were proposed for consideration as follows:

1. Administration and Financial Relationship of State and County.
2. Digest of Legislation Relating to Jurisdiction of County Highways with Particular Reference to Authority of County Engineer.
3. The Relation of the County Highway Engineer to County Highway Planning.
4. Evaluation of Planning Data.
5. Low Cost of Bridges.
6. Maintenance Equipment and Plant.

With the approval of the board, President Washington made the following assignment of major committee chairmanships:

Public Relations—J. W. Mavity, County Engineer, Harvey County, Newton, Kansas.

Design and Construction—Hal G. Sours, County Engineer, Summit County, Akron, Ohio.

Maintenance—Howard B. Keasbey, County Engineer, Salem County, Salem, New Jersey.

Regional Surveys and Plans—George C. Wright, County Supt. Monroe County, Rochester, New York.

Legislation, Administration, and Finance—W. O. Washington, County Engineer, Cameron County, Brownsville, Texas.

The meeting adjourned at 3:30 p. m.

URGENT! TELEGRAPH TODAY!

Appropriation Status

THE status of the Highway Emergency Appropriation in Congress at the present time requires your immediate attention.

The two relief measures in Congress—the Garner Bill in the House of Representatives, and the Wagner Bill in the Senate carry provisions for emergency highway funds. We are deeply concerned about the bill in the Senate and your concerted efforts as well as those of all others interested in highways is necessary in order to be assured of sufficient support to pass the measure in the Senate. The Garner Bill will unquestionably pass the House the early part of the week.

The Administration is absolutely against an appropriation for highways.

Some sections of the Wagner Bill (S. 4755) meets with the approval of the Administration, but the section relating to highways does not. We suggest that you wire and write your Senators urging them to support the Wagner Bill, particularly that section relating to highways. We further suggest that you urge all others interested in highways to do the same thing. A real test is at hand and your cooperation and quick action will assist materially.

The Wagner Bill has been endorsed and similar action is being followed by such influential organizations as the American Society of Civil Engineers, Associated General Contractors of America, American Institute of Architects, Construction League of the United States, National Committee for Trade Recovery. Representatives of these organizations realize that the future of construction activities in general hangs in the balance.

Wagner Bill provisions:

The bill has two definite objectives in utilizing the powers of the Government.

1. To assist the states in preventing hunger. 2. To help in bringing about the resumption of employment and revival of trade.

The bill carries a total appropriation of $2,300,000,000 and embodies in entirety the provisions of the emergency highway construction bill—H. R. 9642—for which we have been urging support.

$1,500,000,000 increase is provided for the operation of the Reconstruction Finance Corporation in extending Governmental credit to states, cities and other political sub-divisions—as well as private corporations for undertakings which are self-liquidating in character.

$300,000,000 is available to the Reconstruction Finance Corporation for the purpose of making advances to the States for relief to the destitute upon certification by the Governor of the State that there is need for such assistance.

$500,000,000 is appropriated for specific projects—among which is the section which embodies the highway emergency appropriation. (Above referred to.)

Open the Throttle

The Road Builders' News

Activities of A. R. B. A.

At the annual meeting of the American Road Builders' Association on April 28 Charles M. Upham, Secretary and Engineer-Director, presented his annual report on the activities of the association during the past year. Extracts from the report follow:

Scientific and Technical Studies—During the past year the association has conducted scientific and technical studies in 22 general subjects of importance to the highway industry. There have been seven joint committee activities with the American Association of State Highway Officials; one with the Highway Research Board; the cooperation with the United States Department of Commerce has been continued; and there has been a most productive cooperative project with the National County Roads Planning Commission. Although the cooperative projects with these various associations will be continued, their number will have to be decreased. Also, the number of the scientific and technical general committee activities will necessarily have to be cut to not more than twelve or fifteen. The work of the committees has established itself on a very high plane and is generally accepted as authoritative. Members of the engineering staff are in constant demand for lectures, meetings and programs, and their efforts in each case are to combine the practical with the scientific and technical.

The past year has plainly indicated that the future efforts of the association should be directed toward maintaining and stabilizing the highway program, even though the scientific and technical committee work will necessarily be somewhat curtailed. Plans have been made, accordingly, whereby one of the major activities of the association will be the compilation and dissemination of statistics and other information useful to those responsible for highway legislation.

American Association of State Highway Officials—The cooperation with this organization in the study of equipment problems has been continued in the same manner as in the previous year. Joint committees were formed, headed by a state highway official as chairman and a staff engineer of the American Road Builders' Association as secretary. Seven joint reports were presented at the annual convention of the American Association of State Highway Officials in Utah last September and at the convention of the American Road Builders' Association in Detroit last January, as follows:

1. Standardization of Rental Rates for State Owned Equipment and the Establishment of the Relationship between these Rentals and those Recommended for Privately Owned Equipment.
2. Equipment for Construction and Maintenance of Low Cost Road Surfaces.
3. Bins, Batches; and Equipment for Handling and Weighing Bulk Cement.

4. Equipment for Spreading and Finishing Pavement Surfaces.
5. Standardization of Shoes or Rollers for Truck and Tractor Snow Plows.
6. Standardization of Blades for Truck Scrapers.
7. Traffic Devices and Their Application.

At the present time there are under consideration several projects to be taken up in joint committee work during the ensuing year.

United States Department of Commerce—The cooperation has been continued with the United States Department of Commerce, as well as with the American Engineering Council, in the study of Airport Drainage and Surfacing. The report has been completed and is now being distributed.

The joint project with the Highway Research Board, "Compaction of Earth Fills as Affected by Type and Size of Haulage and Other Equipment," has created considerable attention among highway engineers and manufacturers. The report was presented at a meeting of the Highway Research Board last December and at the convention of the association in January. The study will be continued during the coming year.

Cooperation with the Associated General Contractors of America was continued during the past year. The contractors' program at the annual convention of the American Road Builders' Association was prepared in collaboration with members of the Associated General Contractors. There is now in operation a cooperative committee with this organization.

County Highway Officials' Division—The County Highway Officials' Division, under the progressive leadership of its President, Otto S. Hess, Engineer-Manager, Kent County, Grand Rapids, Michigan, has conducted an active program of stimulation, standardization and dissemination of up-to-date methods for highway administration, construction and maintenance in counties.

Subjects chosen for committee considerations proved to be popular. Studies of them brought forth enlightening facts. The reports attracted a good attendance and stimulated lively debate at the annual convention sessions. The large number of requests received since the convention for copies of reports from both within and without the county official field indicates that the information they contain is timely. The following reports especially have been in demand:

Uniform Accounting.

Administrative and Financial Relationship of State and County.

Aerial Photographs.

County Planning Manual.

Nineteen state associations of county officials are now affiliated with the County Division as compared with eight a year ago. The plan of affiliation approved March, 1931, provides that state associations of county officials which shall endorse the purposes and objects of the County Division may, upon application to the County Board of Directors, be enrolled as affiliated organizations. The nineteen affiliated associations are representative of county officials in 1,338 counties in eighteen states.

More than 1,000 county officials were registered at the Detroit Convention, giving a record attendance slightly in excess of the previous year at St. Louis. Michigan county officials who turned out in full force were especially helpful in making the meetings and sessions of the County Division a success. Particular credit is extended the officials of Wayne County for their cooperation in both the Division and general association endeavors for the Detroit gathering.

Through the five years since its organization in 1927, the County Highway Officials' Division has become a useful and accepted medium for exchange of ideas and development of standards as to county practices. Its operations have gained national recognition of county accomplishments and enabled county officials to participate with other interests in shaping the highway policies of the nation. The Division is filling an important place in the highway industry.

City Officials' Division—This has been a very active year for this Division. An intensive effort has been made to increase the interest of city officials throughout the country in the work of the organization, and to show to them the value of close cooperation with the Division in the solution of municipal street problems.

Credit for a successful year's activity is given to the committee members and particularly the chairmen for their untiring work and interest during the past year. The work has been conducted by an able leader, the Division's President, Mr. George B. Sowers, Consulting Engineer, Cleveland, O.

The program of committee studies was chosen with great care and the subjects selected were given precedence only after careful consideration had been given to their relative importance.

The following subjects were chosen: Airports; Finance; Design and Construction; Maintenance; Traffic.

Reports on these subjects were presented at the annual convention at Detroit and were discussed at the various meetings. Bulletins containing the entire City Officials' proceedings are being printed and will be published at a later date.

In order to broaden its usefulness the

Division has made an extensive effort to form affiliations with other organizations of Municipal Officials. Such affiliation has been effected with the New Jersey League of Municipalities and also with the Virginia League. Other affiliations are in process of completion.

One of the outstanding accomplishments of the past year has been the formation of cooperative committee work with the following national organizations:

1. American Society of Municipal Engineers.
2. International Association of Public Works Officials.
3. Governmental Research Association.
4. American Municipal Association.
5. International City Managers' Association.
6. International Association of Comptrollers and Accounting Officers.
7. American Society of Civil Engineers.
8. National Committee on Municipal Standards.
9. American Electric Railway Association.

At the annual convention in Detroit there were in attendance 749 city officials from 183 cities in 29 states and Canada. The cooperation extended by the city officials of Detroit helped materially in making the meetings and conventions of the City Division a success.

The City Officials' Division is fulfilling the purpose for which it was intended, namely, the organized activity of a strong group of city officials in the study of municipal engineering as it applies to the street and highway programs. Only by gathering data pertaining to city street construction, economical traffic use, financing and maintenance, and disseminating it to all city officials, can general standards of construction and operation be improved.

General Engineering and Committee Activities—The services of the association's engineering staff has been principally the collecting of highway information and the presenting of it in the form of committee reports at conventions and throughout the year.

Standardization of highway construction and maintenance is approached through establishing current practice in highway activities. At the 24 convention sessions there were 86 technical reports and papers, all of which dealt with current practice.

Special effort was directed to prevent unnecessary duplication of work being done by other associations and at least 15 reports were joint efforts by the American Road Builders' Association with other organizations interested in road building.

The scientific and technical reports and the information service concerned construction and maintenance methods and equipment. Other reports and other information service included statistical data on highway personnel, highway programs, legislation, financing, translations and motor freight.

The primary purpose has been to promote a wider utilization of authentic highway information to the end that the entire highway industry and highway programs may be continued at a healthy level as measured by employment.

The principal activities are listed as follows:

Information Service.
Committees on Construction.
Committees on Equipment.
General Committees.
Planning and Conducting Convention Programs.
Miscellaneous Work.

The six Construction Committees were organized to bring all road builders authoritative and timely information on construction methods used in building and draining highways. The membership included technical men, executives, manufacturers and users. Their reports presented recent developments and good practice in usable form. Representatives of trade associations were of very great assistance in making this work useful to themselves and the American Road Builders' Association.

Seven committees on Equipment worked in cooperation with American Association of State Highway Officials, one with the Highway Research Board and one with the National Ready Mixed Concrete Association. They were organized to utilize the facilities of the American Road Builders' Association and the cooperating associations and to produce results in a relatively short time.

Several committees whose findings are of general as well as specific interest, functioned throughout the year. They reported on administrative and financial highway problems, motor freight and highway location, and the preparation of a Spanish-American vocabulary of highway terms. General subjects selected were those of importance to the entire highway industry and on which up-to-date and timely information was needed, but which had not been developed by other organizations, or which had been developed by others but which had not reached the entire highway industry.

Membership in American Road Builders' Association

The American Road Builders' Association, through its Engineer-Director, Charles M. Upham, emphasizes the need for group action by the highway industry in the following statement:

"Due to extra effort on the part of highway interests, the highway program has not suffered the curtailment that almost every other industry has. This has been due in part to Federal appropriations, emphasized efforts on the parts of states, counties and cities, and the fact that highway work is probably one of the best means of relieving unemployment. However, the extra Federal aid funds have now been utilized, the extra funds of cities, counties and states have diminished; and unless a redoubled effort is made by all interested in the highway program, there will undoubtedly be a very considerable reduction in the amount of money to be spent for roads and streets during the next year; and unless this reduction is checked, 1933 will undoubtedly show a greatly reduced highway program. The remedy lies in complete cooperation on the part of all interested in the highway program—a willingness to submerge and sacrifice individual desires and policies for cooperative effort will hold highway expenditures to the proper amount and the highway program at its proper level."

Public opinion must be aroused by facts. The Association, on behalf of its membership, is now placing highway facts before legislators and officials. The purpose of this effort is to increase employment by constructing revenue-producing highways.

The Association functions as a clearing house to acquire and disseminate educational and scientific information concerning highway activity in the United States, Canada, Mexico, Central and South America, and many European countries. Its membership includes Federal, State, city and county highway officials, honorary representatives of foreign countries, highway contractors, highway transport operators, producers of highway materials, and manufacturers of highway equipment. Group and general committees study problems relating to highway legislation, finance, design, construction, maintenance, equipment, and operation. Their efforts are directed toward development of improved standards which shall eliminate waste, increase efficiency and bring about economy in highway administration. To avoid unnecessary duplication in its research activities, the Association cooperates through joint cooperating committees with other organizations, official and unofficial, having in part similar aims. The results of investigations on the various technical and general problems are presented in report form and discussed at the annual convention of the Association. The final reports are summarized for publication in the convention proceedings and later issued with discussions in bulletins, of which there have been prepared 30 dealing with the purchase, operation and maintenance of road-building equipment, and the selection and utilization of road-building material.

Membership in the American Road Builders' Association helps both the individual and the industry, the members serving both as sources of information and as distributors and users of improved standards and practices. Membership is open to all interested in highway work and the dues are only $3.00 a year.

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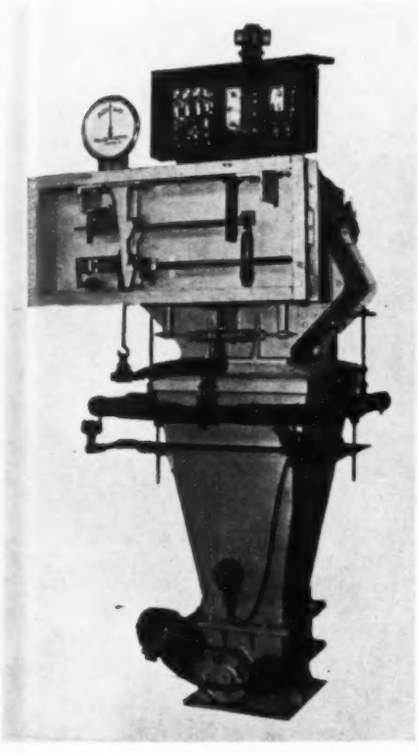
New Equipment and Materials

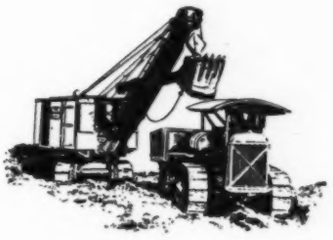
Automatic Weighing Batchers

A new automatic weighing batcher, having a number of mechanical and electrical features of unusual importance, has been announced by Fuller Co., Catasauqua, Pa. The design of these batchers is based upon a flood proof measuring feeder of the highest accuracy. This is the Fuller rotary feeder, cement mill type. Another important part is the Fuller rotary valve, used as the discharge gate of the batcher. The batcher, in brief, comprises the following essential parts: (1) The roll feeder, driven by a built-in motor and speed reducer. A magnetically-operated brake on the drive



New Fuller Automatic Weighing Batcher

shaft engages when the feeder motor circuit is opened, to prevent over-running. (2) A double beam scale is used so that the weight of the apparatus can be balanced by a tare-beam independently of the weigh beam. (3) The batch hopper is supported by the lever elements of the scale and flexibly connected to the flange of the feeder by a canvas apron. (4) The rotary valve or hopper discharge gate is motor driven through sprockets and chain, to permit the operator to control the rate of discharge. This drive is also equipped with a magnetically operated brake. (5) Casing with locks to prevent tampering with scale or other operating parts. (6) Operating circuits, including the starting and discharge push-buttons. Closing the starting push-button switch will not start the apparatus unless the hopper is completely empty; nor will closing the discharge button open the gate unless the weigh beam is in balance. An electric interlock prevents improper operation by manipulation of these switches.



When the tare weight is balanced, and the poise on the weigh beam set for the desired batch, the casing may be sealed and locked, as operation is completely under remote control. The starting push-button may be closed to start the closing of the discharge gate. This circuit is immediately broken and the interlock controls all further operation, to prevent any effect on the operation by improper manipulation of the push buttons. The feeder starts when the discharge gate is closed and locked, and stops when the weigh beam comes to balance. The feeder motor circuit is compensated to allow for the cement in suspension as the roll stops. The discharge circuit is then completed so that the operator may discharge the batch by closing the push-button. The batcher cannot be discharged if the batch is not within the desired tolerance of over or under weight. The discharge may be controlled to prevent loss by splashing out of truck containers ,and when the gate is completely opened, holding the push-button in the closed position operates the vibrator. The discharge gate cannot be closed nor the feeder started until the hopper is completely empty.

These batchers are available in sizes suittable for all mixers.

▼

New Crawler Wagon

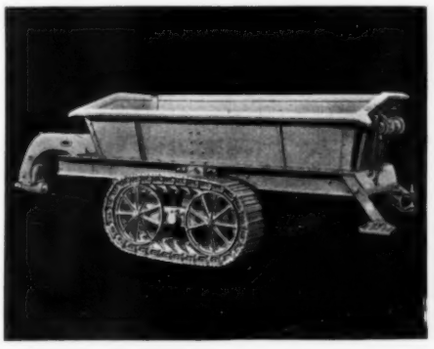
A new crawler wagon—the Forged-Trak Bottom Dump Trailer—has been announced by the Athey Truss Wheel Co., 130 North Wells St., Chicago, Ill.

These trailers have a one-piece box section arch drawbar, with an adjustable and reversible spring mounted, spring cushioned, swivel type tractor hitch. The track assembly has an interlocking self-cleaning structure. It has drop forged track links, having integral interlocking arms. The track pin bearing is of the pin and bushing type. Pin is alloy steel heat-treated. Bushing is carburized. Link is counter-bored to receive bushing, forming seal against entrance of foreign matter.

Four sizes of bottom dump trailers are included in this series—the Model C5 5-yd., C6 6-yd., D7 7yd., and D8 8yd., mounted on the Model C (10-ton), and Model D (15-ton) "Forged-Trak" wheels.

The body is of ¼-in. high carbon steel plate, well braced and reinforced around the top with 4-in. bulb angles and cast steel corner brackets. The improved type partition is of ¼-in. steel plate, heavily reinforced at top with bar stock. Extension sides are furnished on the 6 and 8 yd. units. The front and side sills are 9-in. bulb angles, and the rear a box section steel casting. The front and rear ends have a modified taper and rounded corners; this with countersunk rivets provide a self-cleaning body.

The full length doors are of ⅜-in. high carbon steel plate, reinforced with bulb angles. The hinges are of cast steel with heat-treated steel pins. The hand-operated dump mechanism is of a simplified design for fast, easy operation. It has a single



Athey Forged—Trak Bottom Dump Trailer

hardened steel ratchet and pawl. It also has tempered cable drum with shaft mounted on Hyatt Roller Bearings. The complete mechanism is mounted on a subframe, which is bolted to the body. A spring mounted equalizer sheave minimizes shock on cable. The adjustable and reversible spring mounted, spring cushioned, swivel type tractor hitch has a heat-treated drop forged alloy steel coupling, and all bearings of the assembly are equipped with replaceable hardened steel bushings. This hitch assembly is reversible for direct connection to either tractor or trailer.

▼

A New Scraper Hook-Up

The Highway Trailer Co., Edgerton, Wis., has recently brought out a new power take-off or transmission so that its 5½ cu. yd. scraper can be operated in connection with the new Model "L" Allis-Chalmers tractor.

Power is taken from the tractor for driving the rakers on the inside of the scraper, also for raising and lowering the body when dumping. Capacity loads are stated to be insured by the use of the rakers which carry the dirt back into the pan and at the same time pack it in. This scraper does its own plowing, or scarifying, and it takes only one man to operate each unit. When the scraper is loaded, and while it is on the way to the dump or fill, the body is being raised so that it is in dumping position. The operator uses the

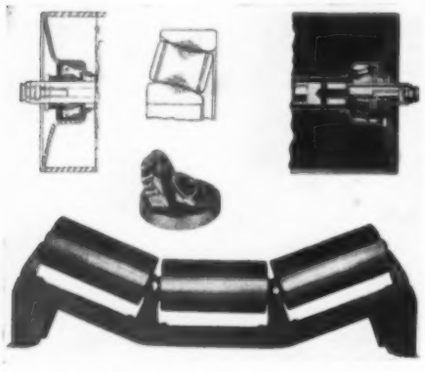
Highway Trailer Scraper Hook-Up with Tractor

trip rope which releases the dumping door so the load can be placed in any exact spot. The dumping door, or tail gate, spreads out the dirt so that it can be built up in any height lifts desired. In this way, round after round can be made without stopping the progress of the tractor at any time.

In addition to this particular hook-up, the Highway Trailer Co. also has a power take-off so that the Highway Trailer scraper can be operated in connection with Caterpillar tractors.

New Anti-Friction Conveyor Carrier

A new anti-friction conveyor carrier has just been announced by the Barber-Greene Co., Aurora, Ill., manufacturers of standardized material handling machines. The roller bearings (Shafer) are of an exclusive design and principle, being self-aligning, and taking thrust as well as radial load. Each size of carrier has but one size roller unit, making these units



Barber-Greene New Conveyor Carrier

and component parts interchangeable. The Barber-Greene carrier is made to interchange with any standard carriers for making replacements.

The roller is made of 5½ in. diam. seamless tubing No. 9 gauge thick metal. The ends are made of pressed steel with the outer roller race inserted under pressure. The inner tube is 1⅛ in. in diameter with two shoulders, one at each of the ends. The spindle is ¾ in. diam. made of selected cold rolled steel drilled and tapped on each end for grease and Alemite, slotted to fit in the end brackets, and provided with two flats to lock the grease-seal washers. The spindle is also drilled and reamed at each end for taper pins. The bearings are held in by the two labyrinth seal washers, shimmed so as to keep bearings tight. There are three collar spacers between the bearing race and the taper pins. In case of wear on the bearings or if for any reason the bearings should be tightened up, it is a very simple matter to take out the taper pin on one side, insert necessary shim, and drive in the taper pin again.

New Austin Distributors

A newly developed line of Austin bituminous distributors, with a number of very practical operating advantages, has been announced by The Austin-Western Road Machinery Co., 400 N. Michigan Ave., Chicago, Ill. The units are built in capacities of 600, 800, 1000, 1200 and 1500 gal. to handle all grades of oil, tar and asphalt, and can be mounted on any standard truck chassis without altering the chassis cross braces, supports, etc. No parts project below sill members, on which tank is mounted. Mountings can also be made on trailers and semi-trailers.

Any desired uniform quantity of bitumin per square yard may be applied over any specified width. Spray bars, or manifolds, of welded sheet metal construction, are tapered to correspond with the reduction in volume, and to provide more perfect drainage when they are removed. If preferred, a full circulating boot type manifold, with individual nozzle shut-offs working in gang formation, can be provided. In the Austin design, nozzles and valve controls are inside manifold pipe where the heat insures complete and immediate drainage.

Tanks are elliptical in shape to provide an extremely low center of gravity without sacrificing capacity, and each has a sufficient expansion zone above. All seams are electrically welded and tested under pressure for water tightness. A full-size manhole with non-breakable, quick clamping lid and a 2½-in. vertical overflow are standard equipment. Asbestos lagging with sheet metal cover can be provided.

Provision for heating includes two large double U-tube flues with generating, non-carbonizing type burners that operate with kerosene or light furnace oils. Before the heat leaves smokestack at front, it must also pass through ten smaller flues, spaced to break up the asphalt mass into small volumes. The arrangement raises temperature of material to any desired point rapidly. Fuel storage and air pressure tanks have sufficient capacity for a day's run.

If steam coils are desired instead of the U-tube construction, a double set of removable coils having eight lengths of tested pipe can be furnished.

Pump is of the internal gear type, with but two moving parts, and has a capacity of 350 gal. per minute at 350 r.p.m. Wide sealing contact at outer surface of rotor gives a higher efficiency and greater displacement per revolution than on other pumps frequently employed for this service. Pump is also equipped with self-aligning, anti-friction outboard bearing.

The straight-through pattern with suction at bottom eliminates objectionable pockets where asphalt would otherwise lodge in heavy quantities. Lubrication, grease cups and packing glands are in accessible location.

A heavy-duty and easily accessible, 4-cylinder motor drives the pump. It is placed at front of distributor to eliminate fire hazard and to prevent the mist and fine spray of asphalt from causing ignition trouble, short circuits and clogged cooling system. Governor and gas throttle rod controls are extended to the rear, giving operator complete control of machine.

Front and rear piping is assembled in an upright position to permit natural drainage and trouble-free starting. The use of flanged pipe fittings and metallic tubing to prevent leaky joints is a most radical departure. Valves and shut-off cocks are of inverted plug, spring loaded type, kept tight at all times by internal springs. Pump and front end fittings are fully enclosed in asbestos covered heat chamber. Full circulation within tank is assured by piping

1000-*Gal. Austin Bituminous Distributor Comes Equipped with Either Removable Tapered Bar or Full Circulating Boot Type Manifold*

arrangement; a by-pass line also permits complete exterior circulation around pump for wash-out or cleaning purposes.

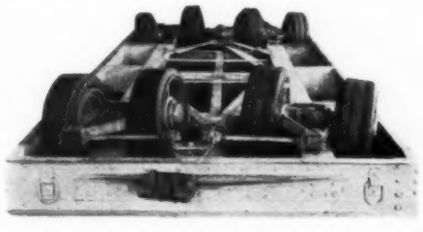
The new Austin distributors are furnished with every modern operating refinement, and in addition they have many features which cannot be described here, including a complete line of auxiliary equipment.

New Two-Way Trailer

A new trailer for hauling heavy construction equipment that can be loaded and pulled from either end has been placed on the market by the C. R. Jahn Co., 1140 First National Bank Bldg., Chicago, Ill.

The frame of this trailer is designed to provide equal distribution of weight over all axles and wheels. The main frame members run the full length of the trailer, and are so spaced that machinery when properly loaded rests directly over the large, wide-flange beams. The short span between axle centers entirely eliminates the possibility of sagging frames. Both ends of these beams are tapered to permit mounting of axle turntables and plates on the lower flanges. The axles are mounted under the frame members with increased pivoting action, and it is possible to steer or apply the brakes regardless of the tilted position these pivoting axles may be in at the time.

The steering of the axles is accomplished by heavy arms securely bolted to axle shaft housing and connected by means of a cross steering rod through universal joints which permits pivoting action without affecting



Upside Down View Showing the Arrangement of the Wheels of the La Crosse Tu-Way Trailer When Taking a Curve.

positive steering. The steering axles at the opposite end from which the trailer is being pulled are co-ordinated by means of a longitudinal reach rod with sliding block connection in the center.

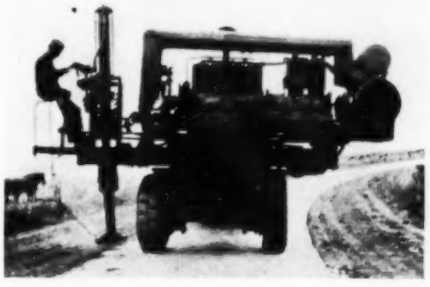
The trailer may be pulled in reverse direction without turning it around. It is stated that less than five minutes are required to change draw bar from one end to the other. The dual end steering is stated to make it possible to take short right angle turns without interfering with traffic on narrowest pavements or streets, and provides unusually short turning radius. The trailer has a double end brake control since brake control wheel is portable and can be shifted to either end. Brakes are applied on all wheels simultaneously. Equalizing brake mechanism provides uniform pressure on all wheels, with maximum safety the result. Brakes may be operated by air or vacuum direct from motor truck.

The flat platform permits loading from either end or sides and it is stated the platform maintains average road level regardless of road conditions, due to independent pivoting action of each axle. This also provides for uniform weight distribution over all tires.

It is stated that the trailer may be operated on narrow highways, with sharp right-angle turns. It may be loaded or unloaded at the job and return over the same route without turning trailer around.

Concrete Breaker and Tamper

A pavement breaker which rotates the same as a power shovel, and works on a radius of 5 ft. allowing it to break to a width ranging from 6 in. to 10 ft. is now in service in the east. The machine is



Pavement Breaker on a Job

known as the rapid pavement breaker. It takes the place of the muscle tiring and slow operating hand operated pavement breakers and the drop ball.

The machine is mounted on a 5-ton truck and is operated with a compressor. It is mounted on the rear end of the truck and by means of a turntable can swing from side to side.

The machine is stated to strike a controlled blow varying from a gentle tap to 18,000 lb. It can strike such a blow 60 times a minute. In trench work the tool is stated to cut to a line without injury to adjacent concrete. The machine strikes a repercussion blow.

By replacing the breaking tool with a tamping tool the dirt in a trench may be tamped as soon as refilled and a permament top put on.

The Concrete Cutting Corporation of America, 52 Clark St., Brooklyn, N. Y., are the distributors for this machine. They also operate the machines in the contracting business in New York, New Jersey and Pennsylvania.

Inland 4-Way Bridge Treads

The Inland Steel Co., Chicago, is now in production on a new product—Inland 4-way bridge treads. These new treads are manufactured from Inland 4-way floor plate, a product announced in September, 1931. The name—4-Way—is taken from the arrangement of the projections. Each projection centers the next projection at right angles so that resistance to slippage is equal in all four directions—forward, backward, to the right and to the left. The projections are higher in the center and thus present friction edges to the tire or foot. Because of the design, projections overlap lengthwise as well as crosswise. 4-Way treads are stated to be just as stiff

Corner of Inland 4-Way Bridge Tread

lengthwise as crosswise. They are supplied in thicknesses from 3/16 in. to 1 in., and in widths from 20 in. to 42 in. Standard length is 15 ft., but odd lengths are supplied as required. Galvanized lag screws are supplied for fastening—6 in. apart across ends, 15 in. apart along sides.

Full Revolving Crane on Cletrac "35"

A full revolving crane has been developed recently for mounting on the Model "35" Cletrac of The Cleveland Tractor Co., Cleveland, Ohio.

The crane has a boom reach of 20 ft. in any direction. The boom length is 21 ft., 18 ft., 15 ft. or as desired. The line speed is 72 f.p.m. for a single line and 36 f.p.m. for a double line. The revolving speed is 4 r.p.m.

The counterbalance revolves with the turn table, keeping the counterbalance opposite the lift at all times. The turn table is revolved by a 6-cylinder, hydraulic radial motor located at the left hand corner of the turn table cover. Another identical motor is mounted on the right-hand corner of the turn table, operating the drum for raising and lowering the cable. Pressure is supplied for operating the hydraulic motors by a radial six-cylinder pump mounted on the rear of the transmission case and driven by the power take-off of the tractor.

Full Revolving Crane on Model "35" Cletrac

Raising and lowering of the cable is controlled by the movement of a single control, which opens and closes a control valve. A similar control regulates the revolving of the boom. Opening the valves one way gives one direction to the motor crankshafts. Closing the valves gives a positive lock. Opening the valves from the other direction gives the opposite rotation to the motor crankshaft. When raising and lowering the load, or revolving the boom, it is positively under control at all times. The closed valve gives a positive stopping of the motor. The boom is angled by the operator from his seat.

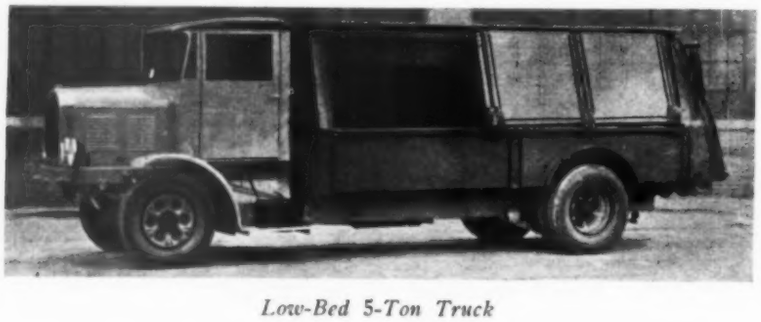
The heavy welded frame is mounted on the Cletrac by fastening the front end of the ⅜-in. steel boiler plate radiator shield to the tractor motor frame, thus carrying a portion of the load on the heavy duty equipment mounting spring, with which the tractor is equipped. The outside support comes on the equipment mounting trunion on the large coil springs.

A New Low Bed Front Wheel Drive by FWD.

A new low-bed, 5-ton front-wheel-drive truck with a frame height of 21 in. has been put in production by the Four Wheel Drive Auto Co., Clintonville, Wis. This truck, designated as the LBU model, is powered by a 91 hp. high compression motor, and is equipped with two sets of brakes, the service brakes acting on all four wheels while the emergency brake acts directly on the propeller shaft. This new FWD low-bed is especially adaptable to specialized hauling applications where hand-loading or unloading is necessary; where the loads are bulky or the commodities fragile. In the refuse collection work this model carries bodies of 10 to 20-yd. capacity and of many different types. Individual rack bodies for hauling plate glass, brick, tile, etc., are available in the standard or special wheelbase jobs. Stock racks, van bodies and standard stake bodies are mounted at the factory to suit the customers' requirements. The company plans also to manufacture this type of truck in other capacities.

The system of power transmission used in the LBU is the same as that found in the regular four-wheel drive vehicles manufactured by the FWD, except that the rear driving mechanism is omitted. Power is transmitted from the motor through a 4-speed unit mounted transmission to the transfer case. Here the power line is dropped down to axle level by means of a 5-in. silent chain which drives the propeller shaft. The front axle is a standard unit such as is employed in the regular FWDs and has the same bevel gear reduction driving the wheels through the patented ball and socket joints.

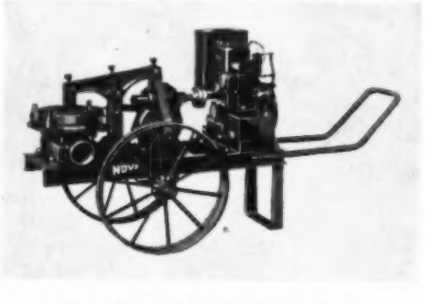
The frame construction of this model is made up of two sections on different levels and joined together by gusset plates. The drop in the frame is made at the rear of the cab and the heavy ½-in boiler plate gussets give maximum rigidity and strength. This type of frame construction, in conjunction with the patented rear axle mounting, gives a straight, clear loading space from the back of the cab to the rear of the frame. The height from the ground to the top of the frame is only 21 in., with the truck loaded. Full spring action is provided by means of four semi-elliptic springs. The front springs are mounted in the regular manner, while the rear springs are mounted on outboard hangers and attached to the drop center rear axle by means of a special forging. This rear axle construction gives maximum ground clearance with full spring action.



Low-Bed 5-Ton Truck

New 3 in. Diaphragm Pump

A new 3 in. diaphragm pump has been brought out by the Novo Engine Co., Lansing, Mich. The pump has a rated capacity of 4,000 g. p. h. at 10 ft. static lift. The power unit is a A. G. 2 hp. one cylinder engine. All gearing is enclosed. The mounting is a 2-wheel truck, with skid optional. The over all dimensions of the truck mounted pump are: Length, 69¼ in.; width, 31¼ in.; height 36 in. The weight is 485 lb. and the total head is 50 ft. An important feature claimed for this pump is that it takes but 3 minutes to make a diaphragm and valve change. This is done by merely removing four bolts from the clamping ring. The pump conforms to the standard of the A. G. C.



New Novo No. 3 Single-Force Diaphragm Pump

A New Portable Troughed Belt Conveyor by Fairfield

A new portable troughed belt conveyor, sturdily built in lengths of 20, 25 and 30 ft. has been brought out by the Fairfield Engineering Co., Marion, Ohio. It is primarily intended for the handling of sand, gravel, crushed stone and other abrasive materials.

New Fairfield Portable 18-in. Troughed Belt Conveyor

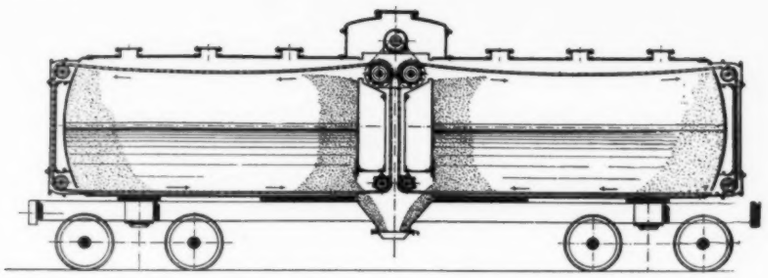
The conveyor is mounted on 48-in. carriage wheels with roller bearings. The conveyor belt is an 18-in. wide high-grade rubber belt. It runs over Fairfield ball bearing idlers. These idlers are closely spaced and are equipped with pressure lubrication fittings. A steel plate receiving hopper at the foot end serves to center the load onto the conveyor belt. The receiving hopper plates are equipped with replaceable rubber wear strips. The conveyor is equipped with steel skirt plates for full length which provide a carying trough 6 in. deep. The return belt is protected against falling materials by a steel plate formed in an inverted "V" shape and running full length of conveyor. To provide efficient traction an 8-in. diameter lagged head pulley is used. A machined worm winch of the self-locking type mounted on side of conveyor frame permits operator to adjust conveyor discharge height readily at all times.

Power is furnished by 3 hp. ball bearing electric motor or 4½ hp. air cooled gasoline engine. Power is transmitted from the motor to the headshaft through steel roller chains and machined sprockets. Main drive chain fitted with idler sprockets and automatic tension spring take-up. Pressure lubrication fittings are provided for all bearings throughout.

Self-Unloading Tank Car for Bulk Materials

The General American Tank Car Corporation in conjunction with Link-Belt Co. has developed a novel and unusual form of self-unloading tank car for the transportation of dry commodities in bulk. Exhaustive tests indicate that this new car is suitable for shipping virtually all types of granular commodities.

In outward appearance the "Dry-Flo" car is much like the tank car, save that it has six openings for loading in the top instead of one. Like the tank car, too, it



Interior of "Dry-Flo" Tank Car

unloads through a single opening in the bottom, and does it automatically.

Inside, the car is different. It is divided into three compartments, two large compartments which carry the lading, while a small one houses the machinery by which it is unloaded. This mechanism is simple, fool-proof and highly effective. It consists of power-driven drag chain conveyors, which are pulled along toward the center outlet by means of sprockets located in the center compartment. The conveyors are driven by a motor located in the dome, or by external power applied to a shaft provided for that purpose. An ingenious gear speed reducer makes it possible to operate the conveyor chains very slowly. Provision is made for throwing out power on one end of the car, should it be desired to unload it at a lower rate of speed, and also for starting one end at a time, should the lading be unduly packed or frozen.

To operate this unloading equipment it is necessary only to open a valve at the bottom of the car and connect up the motor to a source of electric power by means of a flexible cable. This done, the unloading proceeds entirely without assistance.

"Booster" for Heating Bituminous Materials

The Cleaver "Booster," an oil burning, low pressure unit, for heating road oils and other bituminous materials, has been put on the market by the Cleaver-Brooks Co. of Milwaukee, Wis.

A 3-in. line connects the outlet of the tank car to a 3-in. reversible asphalt pump. The material is then pumped from the car through the booster and either back into the car through the dome, or directly into distributors or transfer tanks.

The cut shows the Cleaver Booster heating a 10,000-gal. car of Tarmac T. 50° per hour, pumping the material approximately 165 gal. per minute.

A wide range of pumping and heating speeds are provided on Cleaver Boosters which are mounted on two-wheel trailers or on 1½-ton trucks.

New Street Sign

A new design of wing street sign has been patented recently by A. Sprung, engineer and general manager of the Municipal Street Sign Co., Inc., 299 Broadway, New York, N. Y. Each complete set consists of two double faced No. 16 gauge porcelain enamel signs held in patented and guaranteed malleable iron frames. The over-all size of frames is 7 in. by 23 in., and the lettering is up to 4 in. high. The post is steel, 3½ in. o. d. by 12 ft. long with anchor rod. The bolts and nuts are cadmium plated. The patented features include: Theft proof device in frame to prevent vandalism, and a combination ornamental iron corner piece, cast in one piece with the post cap and collar. The signs can be furnished for attaching to street lighting and trolley posts. They also can be furnished with double name frames showing intersecting street or block number.

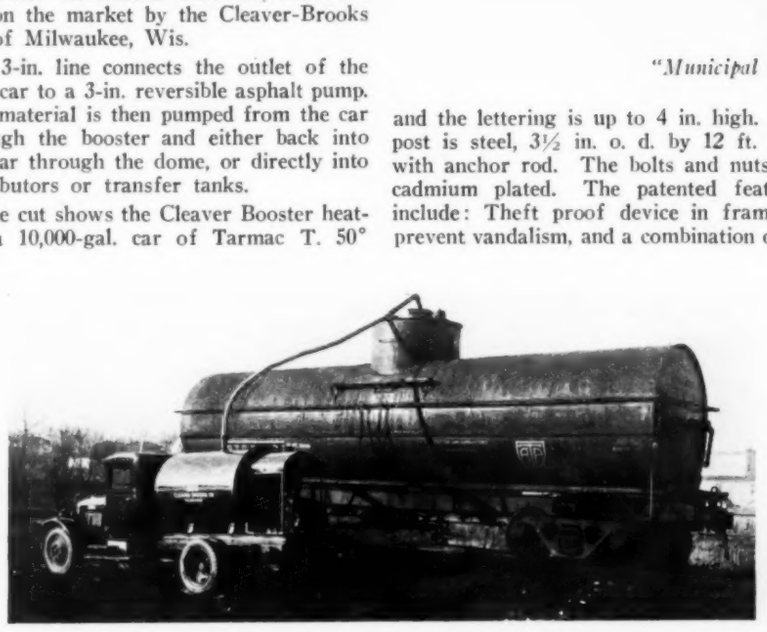
"Municipal Monarch," Type 97-W

New "Caterpillar" Gear Sealing Process

Engineering research department of Caterpillar Tractor Co., Peoria, Ill., has perfected, and the company now has placed in production a gear-sealing process to protect the drive gear in the rear end of tractor from dust, mud and grit. Process, for which a patent has been requested, is stated to accomplish the dual purpose of sealing oil in gears and keeping dirt out through a combination of hardened washers and spring-loaded cork gear housing. The process is being used on most of the new tractor models now in production. The new process costs more than previous methods employed by the company, but results in a more durable product.

Caterpillar Gear Sealing Process

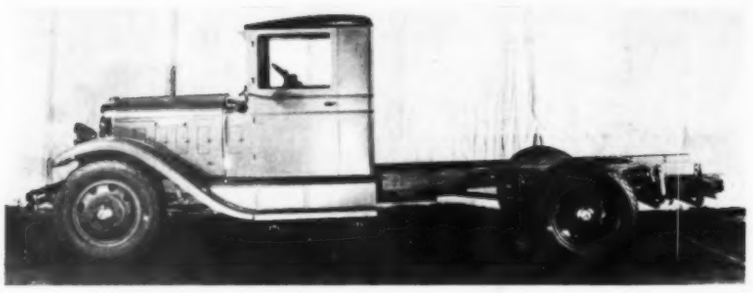
"A combination of hardened and chrome-plated washers, spring-loaded syphon bellows and cork facings" is the way H. T. McDonald of "Caterpillar's" engineering staff describes the new seal.



No. 2 Pumping Booster Heating 10,000-Gal. Car of Tarmac T.

New 1½-Ton Truck

A new 6-cylinder dual-rear-wheel truck with standard wheelbases of 159, 171 and 189 in. has been brought out by The Autocar Co., Ardmore, Pa. This Model R 1½-ton truck is powered by a newly designed Autocar Blue Streak engine with



Model R Autocar Truck

3¾-in. bore and 4¼ in. stroke. This gives the large piston displacement of 314 cu. ins., and the N. A. C. C. horsepower rating of 33.75. At its relatively low governed speed of 2400 r.p.m. the engine yields 75 brake horsepower. The crankshaft rides on seven 3-in. main bearings with a total bearing length of 12¾ in.

Power application is through an Autocar 4-speed transmission with low ratio of 6.41 to 1 and a direct high gear. The standard rear axle has a 5.22 ratio, and is full-floating spiral bevel drive, also of Autocar manufacture. At its governed speed the loaded truck is good for 45 miles per hour and a grade of 4.8 per cent in high gear.

Model R is lavishly supplied with brakes. Four Lockheed internal-expanding shoes have a total of 388 sq. in. of lining. Another strong feature is its channel steel frame, with cross section measuring 6⅞x3x3/16 in.

New 7/16-Yd. Convertible Shovel

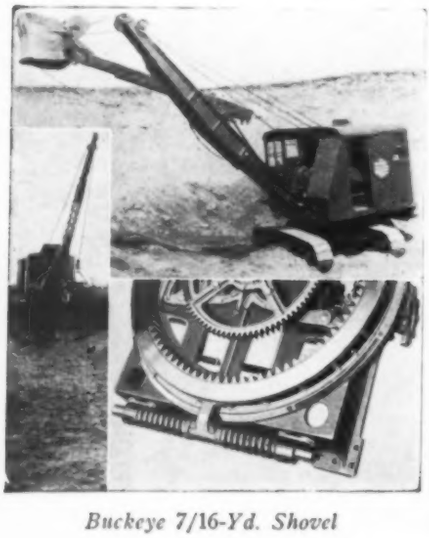
A new 7/16-yd. Buckeye convertible shovel has just been announced by The Buckeye Traction Ditcher Co., Findlay, Ohio. One of the features of this new shovel is the patented spring-stop shock absorber which, it is claimed, entirely eliminates swing clutch slippage and shock to relative parts at the moment of reversing.

A 2-speed gear reduction unit provides a choice of two speeds for every operation. An additional 2-speed selective gear-shift for the hoist drum makes correct drum-speed simply a matter of choice. Cable drums have a capacity of approximately 200 ft. of ⅝-in. cable.

Maneuverability is provided by the full-length alligator traction units controlled independently by two reversing clutches and independent brakes. The ground pressure is less than 10 lbs. per square inch on the treads. The machine travels and is easily steered with the rotating base in any direction. In low gear it is stated to climb the ordinary practical working grades easily. All controls, including engine throttle and gear shift, are conveniently located within easy reach of the operator's seat.

One hundred per cent electric alloy steel is used throughout. Both traveling base and revolving base are one-piece steel castings. Ring gear is of cast steel, with internal teeth. All spur and bevel gears are machine cut from electric steel blanks and heat treated. Principal shafts are chrome-nickel steel, heat-treated, and ground. All shafts are rigidly supported by bearings mounted on finished cast steel bases. Drive shafts controlling rotation, traction and boom hoist are mounted in Timken roller bearings. Alemite pressure lubrication of all bearings simplifies maintenance. Twin disc clutches provide accurate control. Adjustment at one point on each clutch assures uniform contact of friction discs.

Power is supplied by a 4-cylinder, 4½-in. x 6¼ in. heavy tractor-type Waukesha motor, developing 50 hp. at 1200 r.p.m. Regular equipment includes electric starter, generator and storage battery. Motor is mounted on a solid cast sub-base as a complete assembly with the radiator, clutch and transmission unit.



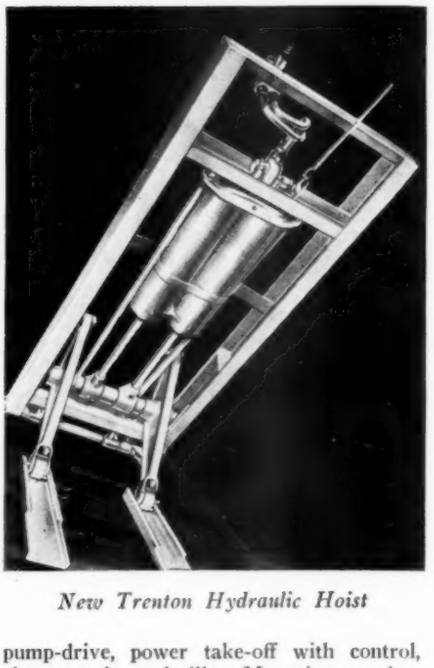
Buckeye 7/16-Yd. Shovel

New Hydraulic Body Hoist

A new hydraulic body hoist with equalized pressures and unit construction has been announced by Fitz Gibbon & Crisp, Inc., Trenton, N. J. The hoist has a high angle lift and quick action and is a complete, self-contained, compact unit. Improved design applies abundance of power without subjecting either chassis or hoist to undue strain. The load is evenly distributed over a large chassis area. Maximum hydraulic pressures are low. Valves in cylinder head, and other novel features are stated to contribute to trouble-free operation.

The hoist is built in two single cylinder and two twin cylinder models to cover all load and dumping conditions.

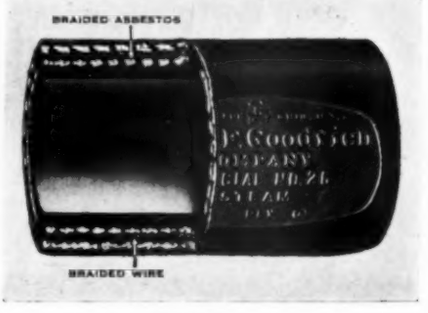
All models are complete units, including: cylinders, pump, lifting arms, hinges, pump-drive, power take-off with control, clamps and wood sills. Mounting requires no drilling of holes nor other fitting, it being merely necessary to clamp the hoist unit on the chassis.



New Trenton Hydraulic Hoist

New Steam Hose

A recent product of the B. F. Goodrich Rubber Co., Akron, Ohio, is its new Type 26 steam hose, which started to extend the use of rubber steam hose, affording many important properties. In this hose the insertion consists of braided asbestos, combined with wire.



Type 26 Steam Hose

Type 26 hose is made in sizes ½ in. to 2½ in. inclusive. All sizes 1 in. and up are made in three braid construction only. The ¼ in. and ¾ in. sizes are made with two braids, one asbestos and one wire. Fifty feet is the maximum length.

ALUMINUM TRUCK BODIES—For the U. S. Bureau of Mines fuel yard in Washington, six automobile dumping trucks were built in 1931 to haul coal, with bodies wholly of aluminum, excepting the hoisting mechanism. These bodies are 11 ft. long, 7 ft. wide and 3 ft. 9 inches high inside; they weigh 1,420 lbs. each. Each truck travels 50 to 60 miles a day.

Distributor News

S. F. Beatty Elected President Austin Manufacturing Co.

Austin Manufacturing Co., of Chicago, announces the election as its president of Mr. S. F. Beatty, who is well known to the road builders of this country through his activities as president of The Austin-Western Road Machinery Co. and of The Road Machinery Manufacturers' Association, as well as through his many years of service as officer and director of the American Road Builders' Association.

Mr. W. T. Beatty, for many years president and general manager of the Austin Manufacturing Co., has been elected chairman of the Board, while Mr. K. N. Forbes has been elected vice-president.

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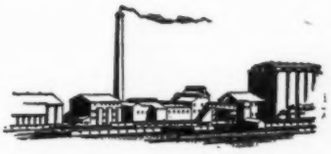
Caterpillar Tractor Co. Strengthens Dealer Organization

In spite of the "greatest depression in history" Caterpillar Tractor Co. has not only consistently increased its dealer organization throughout the world, but replaced some of the weaker dealers who could not stand up under the strain, with stronger dealers.

Here are some of the new "Caterpillar" Dealers that give some idea of the class of sound going business concerns that have been added to the "Caterpillar" Sales Organization:

Western Motors, Ltd., Brandon, Manitoba, Canada.
Stouffer Tr. & Eq. Co., Harrisburg, Pa.
Jack Neal Sales Co., San Antonio, Tex.
Syracuse Supply Co., Syracuse, N. Y.
Hunter Machinery Co., Milwaukee & Madison, Wis.
John East Iron Works, Ltd., Saskatoon, Sask., Canada.
The General Supply Co. of Canada, Ltd., Toronto & Ottawa, Ontario, Canada.
Rio Grande Hardware & Machinery Co., Harlingen, Tex.
Bert Smith Road Machinery Co., Enid, Okla.
Haight Tractor & Equipment Co., Des Moines, Iowa.
Georgalina Tractor Co., Augusta, Ga.
Tractors & Equipment, Ltd., Fredericton, N. B., Canada.
Grand Forks Tractor & Equipment Co., Grand Forks, N. D.
Gleason Motor Car Co., Shamokin, Pa.
Smith Tractor & Equipment Co., Irvington, N. J.
Flowers Tractor & Equipment Co., Omaha, Neb.
Cliff Miller Tractor & Equipment Co., Council Bluffs, Ia.
Spring Grove Tractor & Equipment Co., Cincinnati, O.
Jarvis-Tull Tractor & Equipment Co., Plainview, Tex.



F. Rendon & Hermano, Nuevo Laredo, Tamps, Mexico.
Connelly Machinery Co., Billings, Mont.
Glendive Tractor & Equipment Co., Sidney and Miles City, Mont.
Quincy Tractor Co., Quincy, Ill.
W. T. Walsh Equipment Co., Cleveland, O.

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Donald M. Ryerson Dies

Donald M. Ryerson, Chairman of the Board of Joseph T. Ryerson & Son, Inc., Chicago, ended his life May 8th at his home in Lake Forest, Ill. He had relinquished active management of the business some time ago and had become interested in problems of national importance, working so continuously that his health became impaired. He had been under a physician's care for some little time and had been endeavoring to recover from a nervous breakdown that occurred last October.

Donald Ryerson became an active worker in the Ryerson Company in 1906, progressing through various departments of the business to the office of chairman. In business life he quickly won the warm regard and respect of his associates in the steel producing and consuming industries. During his active years he proved a brilliant leader, not only for his own organization but for the entire warehouse industry as well.

Mr. Ryerson was educated at Yale. Prior to the war, he conceived the idea of the Four-Minute Men, a national organization of speakers that were taken over by the government for use in the Liberty Loan and other campaigns. The success of the plan won the personal commendation of President Wilson. A few days before our entry into the war he also personally contracted for a submarine chaser which was turned over to the government. He then attended the first reserve officers' training class at the Naval Academy at Annapolis and served as a lieutenant on the U. S. Destroyer Sigourney off the coast of France.

He is survived by the widow and two children and in the business by two brothers, Edward L., President of the Company, and Joseph T who is Treasurer.

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American Cable Company Licenses Another Rope Firm

The American Cable Company announces that the Wickwire Spencer Steel Corporation has recently been added to the list of wire rope manufacturers licensed to manufacture preformed wire rope under the American Cable Company's patents.

Other companies in the United States who are licensed to make preformed wire rope are: American Steel & Wire, Broderick & Bascom Company, E. H. Edwards Company, Hazard Wire Rope Company, Macwhyte Company, Pacific Wire Rope Company, General Cable Corporation and the Wire Rope Manufacturing & Equipment Company.

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Harry Collins Distributor for Link-Belt Shovels

Harry C. Collins Machinery Co., 2013 Santa Fe Ave., Los Angeles, Calif., has been appointed distributor in Los Angeles and adjacent territory, for the Shovel and Crane Division, Link-Belt Co., Chicago. Harry Collins is not a newcomer to the Link-Belt line of shovels-cranes-draglines, as he has previously represented the company. Collins has had 25 years' experience in handling all classes of contractors' equipment.

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Barber-Greene Appoints W. B. Holder Boston Office Manager

The Barber-Greene Company, of Aurora, Ill., manufacturers of standardized material handling machinery, announce the appointment of Walter B. Holder as branch manager of their Boston Office.

Mr. Holder has been with the Barber-Greene Company since 1926, for the most part in the capacity of head of the coal handling line. Prior to coming with the company, he had 11 years' experience desigining coal elevating and conveying machinery with the Underwood Machinery Co., and the Mead-Morisson Manufacturing Co., of Boston, and George P. Carver, Inc., coaling plant builders and engineers.

After being graduated from high school, he took two courses in mechanical and structural engineering, conducted by the Massachusetts Institute of Technology. At the outbreak of the World War, he enlisted in the United States Navy and served until 1920, when he resigned with the rank of Lieutenant,

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Wire Maker Announces New Warehouse Location

For years—the American Steel & Wire Company, a subsidiary of the United States Steel Corporation, has served the users of wire and wire products in the Chicago district from its local warehouse at 403 West Lake St. But—sooner or later—the old must give way to the more modern—even in warehousing and distributing. At its new Chicago warehouse, located at 2354 South Ashland Ave., which supplants the Lake Street location, the company will have the distinct advantage of a near south side location.

Service Exchange
for Manufacturers and Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives of their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New Lines Wanted

Would like to secure distributorship for a line of contractors and road builders equipment. Warehouse facilities available Amply financed.

Man experienced in asphalt work desires position with construction or machinery manufacturing firm contemplating entering Latin American markets.

Distributor, well known in outlying towns of Western and Northern New York, handling some well known lines desires to secure additional road machinery and equipment accounts.

Distributing company being formed to handle municipal equipment and supplies for southern Iowa and northern Missouri; will have high class sales force in the territory. Desire to hear from manufacturers of water works, sewerage, street and fire department equipment and supplies desiring distributors and sales agents in the above territory.

Municipal engineer: design, construction or operation of water works and sewage disposal plants. Twenty years' experience, past ten years chief engineer with consulting engineer. Experience in design and construction of dams, pipe lines, filter plants, sewer systems, sewage disposal plants, sewer systems, bridges. Location anywhere moderate salary.

District sales engineer—formerly with leading manufacturer of excavating machinery for number of years, desires similar position. Familiar with export.

Construction engineer, Danish, many years' experience as field engineer, and superintendent on dock, bridge and building construction in Denmark, Norway, Sweden, Iceland, Germany and for the past five years in U. S. A., now living in Wisconsin. Also was traveling sales engineer in Scandinavia. Would like to hear from manufacturers of building specialties and contractors equipment who are looking for a representative in Scandinavia and countries along the Baltic Sea.

Representation in New York City wanted for construction and industrial equipment by newly organized firm whose personnel has wide experience selling contractors, and engineering and industrial concerns in this area. References and qualifications gladly given.

Newly organized distributing company located in Boston, desires to secure a few road machinery accounts for New England territory.

Distributing organization located in Tennessee desires to handle a complete line of road building equipment.

Manufacturers' representative, clientele, state of New Jersey. Can represent manufacturers or contractors machinery, accessories, materials for general contractors and stone crushers. Large or small units.

Distributor situated in Portland, Oregon, desires line of stationary diesel engines, from 75 to 150 hp., to serve western trade for driving rock crushers and industrial plants.

Sales engineer, experienced in earthmoving machinery, desires connection on salary or salary and commission basis. Wide acquaintance with machinery dealers, oil and gas industry, pipe-line contractors and material men. References.

Representatives Wanted

Manufacturer of armored runways for wooden bridge floors seeking distribution points in West Central States including Wyoming, Colorado, Nevada, Montana, Arizona, Idaho, Utah, New Mexico, North and South Dakota, Nebraska and Kansas.

Manufacturer desires responsible representatives in principal cities in United States and Canada to distribute a new type machinery trailer with many new exclusive features protected by letters patent.

Manufacturer of crushers, screening plants and maintainers desirous of securing distributors in Eastern part of the country.

Manufacturer of contractors' pumping equipment is desirous of obtaining representation in Washington, Oregon, Texas, Minnesota, Wisconsin and North Carolina.

Manufacturer of sacrifier maintainer wishes to have his product manufactured and sold in other states outside of Minnesota. Agents wanted in every county in Minnesota.

Manufacturer of a new Crawler Dump Wagon desires distributors in the Middle West territory.

Manufacturer of a high-grade truck snow plow desires distributors in the Middle West territory.

Manufacturers of road rollers with various attachments would like to make connection with aggressive distributors in Tennessee, northern Mississippi, Alabama, Arkansas, Oklahoma and southern Texas.

Manufacturer of vapor spray cleaning device used by contractors for cleaning construction equipment and also for removal of dirt, grease, etc., from the surface of stone and brick structures, wishes to secure sales agents in the larger cities.

Manufacturer of crushing and screening plants wants a representative in Manila, Philippine Islands.

Local dealer or salesman wanted—who is personally acquainted with his city or town officials. Can earn liberal commissions selling street signs. Used in over 350 leading cities.

Textile manufacturer wishes sales representative to handle complete line of tarpaulins. Distributors, now handling road building equipment and other contractors' supplies, especially desired.

Manufacturers of ditching and trenching machines, to facilitate the laying of pipe lines has liberal proposition to offer dealers.

Manufacturer of metal traffic lane markers for pavements, has a number of desirable territories open. Write for their proposition.

Manufacturer of patented highway and zone marking machine desires sales representatives who are acquainted with highway officials in their own state.

Manufacturer of grader wants dealers in west and east central states.

Manufacturer of a new tractor dump wagon has a number of desirable territories open. Full cooperation extended to distributors.

Manufacturer of asphalt ingredient adaptable for use in the road or industrial field, is seeking representatives for desirable territory in various parts of the country.

Manufacturer of transverse testing machines desires to build up distribution organization in this country and abroad.

Territory open in several states for representatives to handle grade-rippers, mechanical plows.

Manufacturer of steel dump bodies and oil heaters seeking distribution points in west central and southern states, including Missouri, Kansas, Iowa, Nebraska, Colorado, Kentucky, Tennessee, Mississippi, Arkansas, Louisiana and western half of Illinois.

Manufacturer of complete line of construction equipment, mixers, saw rigs, plaster and mortar mixers and pumps has an open territory in the state of Maine and is looking for an aggressive distributor to represent him there.

One of the leading manufacturers of surveying instruments in the United States is seeking responsible agents in all sections of the country. Instruments are nationally advertised in all leading engineering journals.

Eastern manufacturer of grade-rippers, scrapers and road hones has desirable territory open for distributors.

Manufacturer of patented luminous highway danger signs and signals is interested in securing aggressive representation in various parts of this country and Canada.

California territory available for distributor wishing paving expansion joint account.